PHASE MOTION CONTROL

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English

Software Manual

Release 1.4

TorqueWireLine

AxM

Configurable Motion Control Platform

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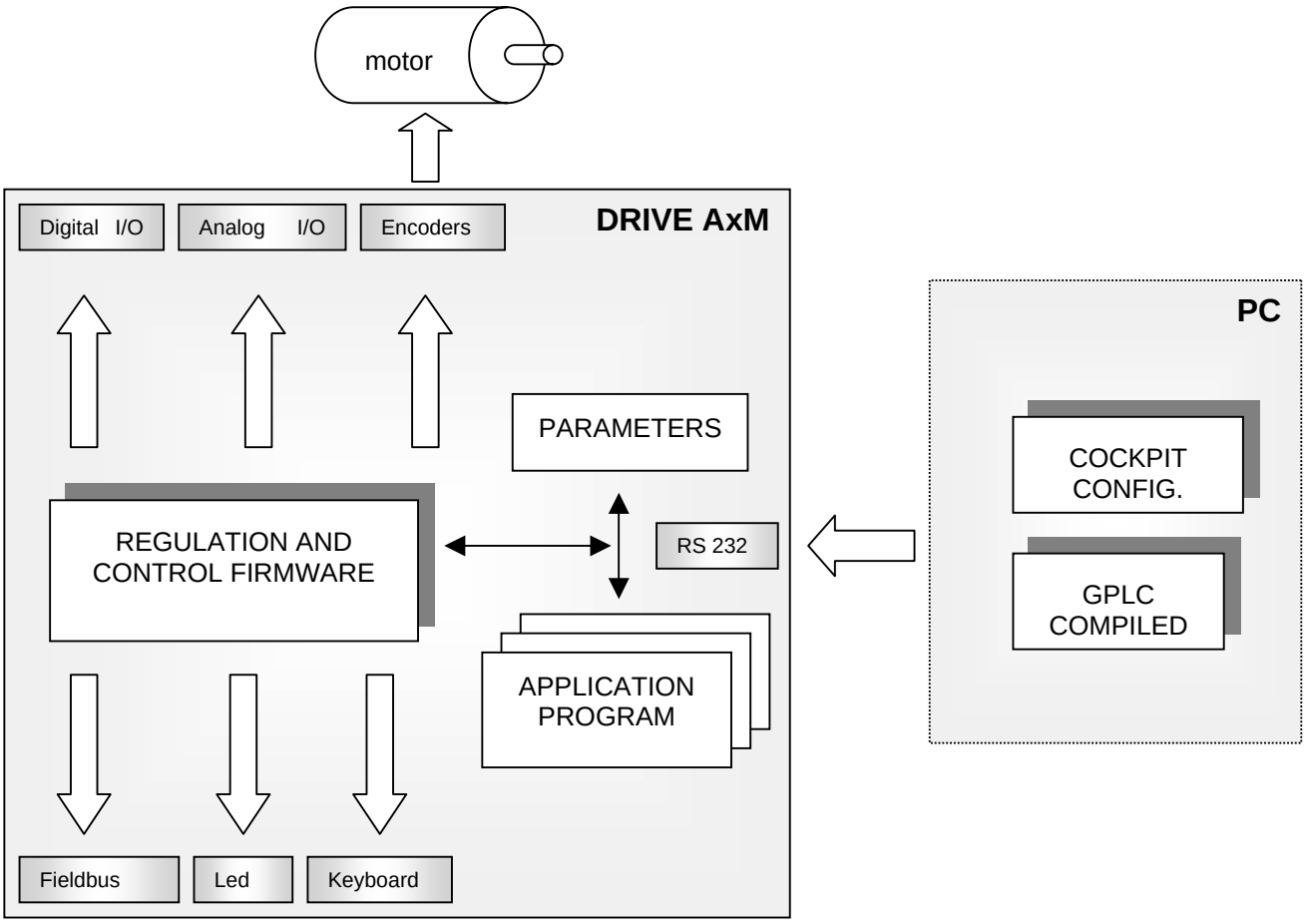
1 INTRODUCTION

This manual shows how to install and put in operation the programmable AXM drive for brushless servomotors control: moreover the software development tools are presented, for parameters setting and drive programming.
Carefully read all the following chapters before to start up the drive.

2 AXM DRIVE OPERATION

The AxM is a programmable platform for brushless servomotors control. The regulation and control functions are managed by a firmware integrated into the drive itself. Some algorithms allow to control motor speed and current and to accomplish positioning functions with trapezoidal or step profile, electric shafts, and step motors simulators. Again: interfaces with peripherals as: encoder inputs, analog-digital inputs and outputs, fieldbus inputs and outputs are currently run. AxM is supplied with control pushbuttons and led display for alarms signals.
On the drive is available a serial interface RS 232 by which is possible parametrize and monito the operating conditions using dedicated software environments. (see par. 3.3): The use of the parametric interface makes it easy and versatile the drive configuration.
In addition to the integrated firmware, in the AxM drive is present a software module for dedicated applications execution, developed in PLC language, according to the international standard IEC 1131-3. The activation of dedicated applications grants a high freedom in use of Analog-digital and makes possible the implementation of additional performances not included in the drive base operation. The development, compilation and downloading into the drive of the user applications, are carried out by a dedicated Phase Motion Control software environment (see par. 9.1).



2.1 Base mode

The mode base, or “default”, allows the use the drive without the loading of a dedicated application (PLC) and also with no remote control on the Can line. Phase Motion Control supplies the AXM drive scheduled for “default” mode operation. In this mode the motor current and speed can be controlled.
Commands and controls are given by the activation of suitable signals to the digital inputs and the current and speed references to the Analog inputs.
The following table (Table 2.1) resumes the inputs configuration.

Input	Abbr.	Function	Description
Digital 0	DI0	Drive enabling	The drive is enabled on the input raising edge.
Digital 1	DI1	Zero reference	When the input is high, the references are put to zero.
Digital 2	DI2	Polarity inversion	When the input is high, the set references are inverted.
Digital 6	DI6	Control selector	When the input is high, the motor speed control is selected, otherwise the current (torque) control is selected.
Analog 0	AI0	Speed reference	Acting on the drive input AI0 voltage, the speed reference is modified when the drive is under speed control.
Analog 1	AI1	Current reference	Acting on the drive input AI1 voltage, the current reference is modified when the drive is under current control

Table 2.1: Base mode used input

The drive enables the digital outputs related to its operation condition.

Output	Abbr.	Function	Description
Digital 0	DO0	Drive Ok	The output is active when the drive is enabled and no alarms are present.
Digital 1	DO1	Run	The output is active when the refernce command are reached.

Table 2.2: Base mode managed output

Using the configuration interface Cockpit it’s possible to activate always the mode “**default**”, setting the related system parameter IPA 18051, SYS_SEL_MODE (see par. 4.8) whatever application loaded on the drive is disabled until such parameter should be set to “**Plc**”. Otherwise this parameter can be set to “**Remote**”, to transform AxM in a CANopen standard node, or “**Test**” to enable the test routine for the encoder phasing (only sincos in the Mplc 4.0).
Similarly, it’s possible to set the fundamental drive parameters, such as those related to the motor, encoder type and features, inputs and outputs configuration, speed and acceleration limits. To find a detailed description or the drive parameters, refer to Chapter 4.

2.2 Mode user applications (PLC)

In addition to the base functions, could be necessary the development of additional performances. On such subject Phase Motion Control supplies some base applications normally satisfying the more common control requirements. The activation of such dedicated applications requires theyr downloading into the drive and the setting to “Plc” of the system parameter SYS_SEL_MODE. A detailed description of the supplied applications is developed in the chap. 7.

For very special control exigencies, the user can develop and execute his own applications, making use of the AxM drive extreme versatility to satisfy a very large range of control/regulation conditions and to fit the specific configurations of input/output interfaces and of external communication. For development, compilation and execution of dedicated applications, refer to the chap. 8.
As for the mode base applications, the user application activation requires to set at “Plc” the system parameter SYS_SEL_MODE.

3 START UP

Following are listed all operations to be carefully completed for the first AxM drive start up.

- Connect the motor to the drive following the diagrams of the “AxM User Manual”.
- Connect the drive to the auxiliary power supply 24V.
- Connect a PC COM output to the drive RS232 serial port (S1) with a serial null-modem cable (female-female).
- Activate the Cockpit configuration tool to configure the fundamental parameters.

We pass over the first three points; for them refer to related connection diagrams of the user manual.
Following you can found the all the procedures for the configuration of the drive.

3.1 Led display

When switched on, the drive lights for an instant all the leds, then in sequence the led 0 for ab. one second and led 7 flashing at 1 Hz frquency, thus indicating the drive correct operative condition.

During the drive normal operation, following operative conditions are monitorated on the led display (more than one signal con be on together).

Operative conditions

Drive condition	Led on	Lighting mode	Description
Drive Ok	7	1 Hz flashing	The drive is Non Enabled without alarms.
		Always on	The drive is Enabled without alarms.
Serial communication	6	Variable frequency flashing	The drive has a communication in progress with a remote PC on the serial line.

CAN interface state if SYS_CANOPEN_ ENABLED = ON	6	Always on	Drive on OPERATIVE state
		Flashing	Drive on PRE-OPERATIVO state
		Always off	Drive on Hardware ERROR state – Bus Off
Limite di corrente	5	Variable flashing	The drive is supplying a current equal to the limit value.

Table 3.1: Led meaning

When the drive is in alarm or in error, all signals related to the operative condition are cancelled and the leds from 0 to 4 show the alarm code. A detailed description of all alarm active on the AxM drive is reported in chap. 11.1 Appendix 1.

Alarm conditions

Drive condition	Led on	Lighting mode	Description
Alarm	0,1,2,3,4	1 Hz flashing	Drive in alarm: the binary code of the active alarm is shown. Refer to §11.1 Appendix 1 for the individual alarm codes and descriptions.
System fault	0,1,2,3,4,5,6,7	1 Hz flashing	System fault originated by a control and regulation firmware error. Contact the Phase Motion Control Customer care service.
Boot error	6	Fix	At the system start up, an initialization error of the control and regulation firmware occurred. Contact the Phase Motion Control Customer care service.

Table 3.2: Allarm signaling

Moreover, during the firmware download procedure the follows led are on:

- The led 6 on segnalizes the drive syncronization
- Also the led 6 is flashing during the code download from the PC
- The led 3 on for few seconds segnalizes the Dsp code download
- All led flashing for a reset cycle.

Refer to par. 3.6 For the complete procedure.

3.2 Drive parametrization

The fundamental drive parameters set up can be suitable for the system the user wants to control: it's necessary, therefore, to accomplish a preliminary drive configuration, setting parameters such as: motor type and features, encoder, limits and gains etc
For a detailed description of all drive system parameters (among them the factory set values) refer to chap 4.

Follows a description of the procedures for drive configuration, introducing the user to the software tool "Cockpit" utilization: for its detailed description refer to the related Manual.

3.3 The Cockpit configuration tool

COCKPIT is a program running under Windows 95/NT: it allows to configure the digital AxM and AxV drives and the TW motors through serial interface RS232 or CANopen bus.
It's main features are:

- Serial communication RS232 (MODBUS protocol), or CANopen with CANpc interface (see istruction manual, doc. N° SP02002)
- Drive identification and control.
- Use of graphic pages in HTML format.
- Drive parameter reading and writing, copying, transferring and saving on file.
- Parameters saving in the drive flash memory.
- Drive control and monitoring.
- Drive firmware updating.
- Initialization and remote control through the Control Panel utility.

As soon Cockpit is selected, it starts in "Application Manager" mode. The introductory screen is shown in the following figure.

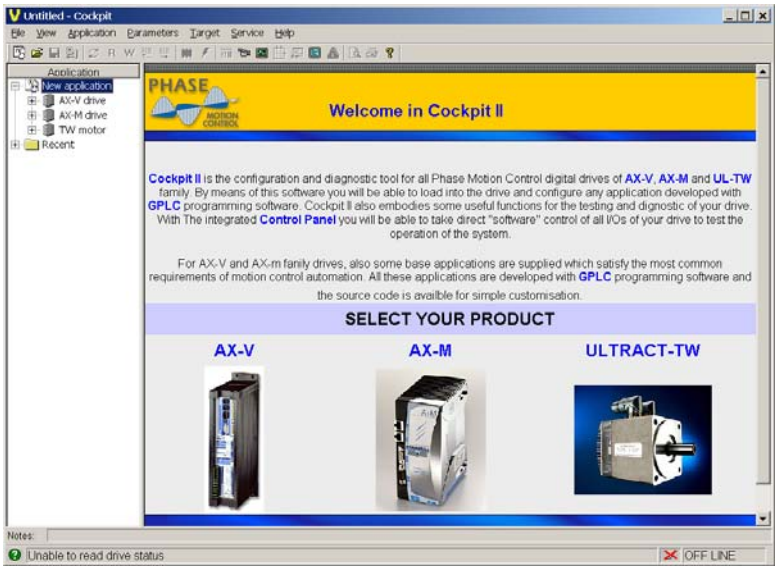

Untitled - Cockpit
File View Application Parameters Target Service Help
Application
New application
AX-V drive
AX-M drive
TW motor
Recent
PHASE
MOTION CONTROL
Welcome in Cockpit II
Cockpit II is the configuration and diagnostic tool for all Phase Motion Control digital drives of AX-V, AX-M and UL-TW family. By means of this software you will be able to load into the drive and configure any application developed with GPLC programming software. Cockpit II also embodies some useful functions for the testing and dignostic of your drive. With The integrated Control Panel you will be able to take direct "software" control of all I/Os of your drive to test the operation of the system.
For AX-V and AX-m family drives, also some base applications are supplied which satisfy the most common requirements of motion control automation. All these applications are developed with GPLC programming software and the source code is availble for simple customisation.
SELECT YOUR PRODUCT
AX-V
AX-M
ULTRACT-TW
Notes:
Unable to read drive status
OFF LINE

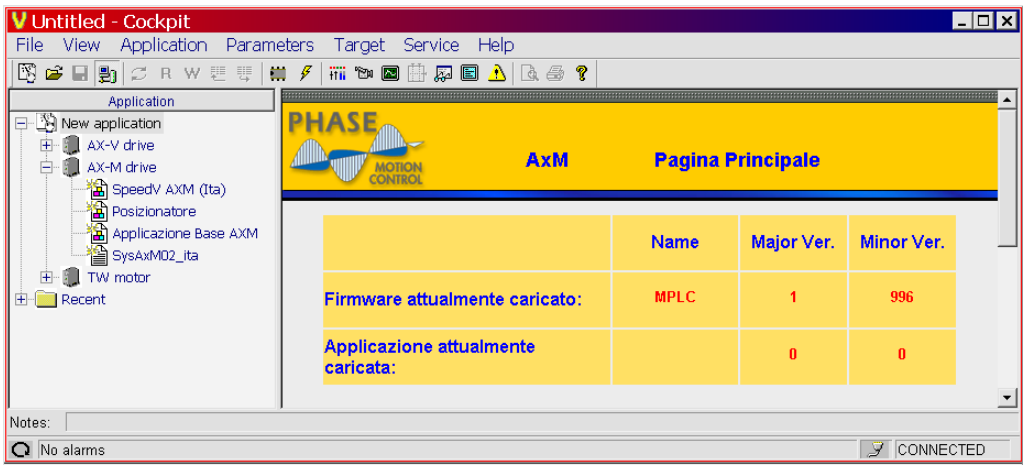
Figure 3.1: Principal screen view

After selected the "AxM" target type, press the suitable key **(Connect)** on the instrument bar, to activate the communication with the drive (or select *"Connect*" from menu "*Target").*

On this new window you have the actual firmware and application software indications.

Figure 3.2:

AxM Main page



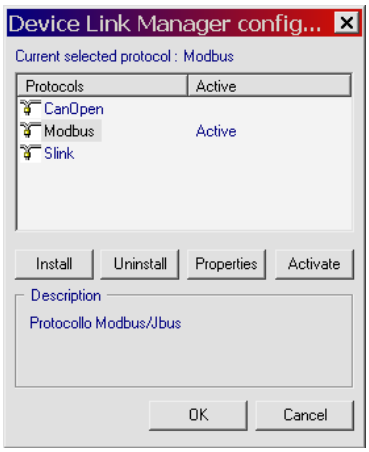
On the status bar, righy down, the connection condition is visualized: when problems in connection fixing arouse, the communicayion parameters must be set (see 3.3.1).
When the communication is active, the status bar at low of the screen, shows the connection condition and the presence of possible drive alarms.

Figure 3.3: Connection active

3.3.1 Communication parameters

The communication with the drive is accomplished by Modbus multi-drop protocol, on a RS 232 serial line.
To communicate with the drive it's therefore necessary a RS 232 port on the PC connected with a serial cable (null-modem, female to female) to the RS 232 drive port (S1), according to the user manual specifications (Cap. 8.5).
The communication starts automatically when the user selects and opens a new parameter file. The user can disconnect and reconnect the communication using the suitable menu command.
When the connection is active, the related menu voice appears selected (tick sign) and the digit on the instrument bar appears as pressed.

An appropriate window allows to select and modify the communication parameters.



To find it select the voice *"Communication settings"* from the *"Target"* menu. Select the modbus protocol and press the Properties key.

The default parameters are: COM1, 38400 baud, no parity, 8 data bits, 1 stop bit. The protocol default settings are: Address 0, Timeout 1000.

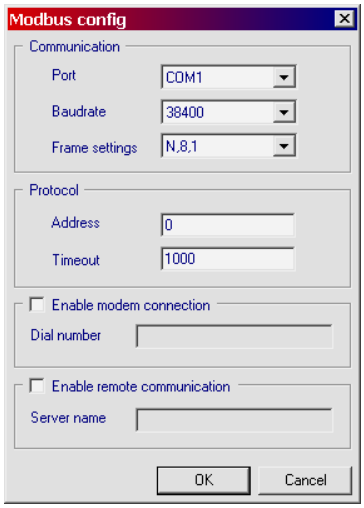


Figure 3.4: Communication parameters setting

NOTE: In order to correctly communicate with the drive, the value of the field Address must be identical to the address given to the drive.
The drive address can be verified and modified using the windows "Target information":

When the address has been modified, it must be saved into the flash memory (Set key).

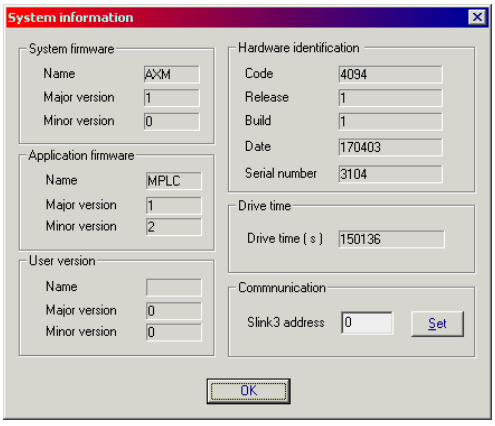


Figure 3.5: System information window

3.3.2 Parameters use

The AxM digital platforms are fully programmable and all parameters sets for the system configuration and operation are resident in the memory.
When the drive is turned on the first time, it is started in "default" mode, using a default parameters table allowing to control, with limited performances, the most part of the Phase Motion Control standard brushless motors. The default configuration parameters are saved in the drive flash memory when assembled in factory; a copy of the default table is included by Setup in the Cockpit work directory, so that it will be possible in every moment and in all cases go back to the initial configuration.
Starting up, the Cockpit configuration tool asks to load the system parameters table (file sys_AxM_04.par) from the work directory with the *"Open"* command of the *"File"* menu.
the parameters can be organized in different "logic" menus, so allowing to visualize of the full series or of a subset only.
Some fundamental parameters are also accessible in form of graphic HTML pages.

Every parameter is defined by following fields:

IPA	parameter index, as defined by the MODBUS protocol;
NAME	mnemonic name, used for parameter identification;
TYPE	data type of the parameter (int, word, long, dword, float, bool);
VALUE	includes the actual value as read by Cockpit;
UNIT	reference to the parameter unit measure;
DESCRIPTION	Explicit parameter description;
NOTE	(in the status bar) visualizes optional information related to the selected parameter.

The user can only modify the value field of each parameter.

Now it's possible to establish a connection with the drive: it's advisable, at the first start up, to fully read all drive parameters, to verify if the used table is consistent with the *"Read all"* command of the *"Parameters"* menu (or with the **Read all** key of the instruments bar).
The parameter singularly selected can be read using the "*Read parameter*" command of the "*Parameters*" menu (**Read** R key of the instruments bar).
The drive parameters can be now modified as desired. When a value is modified, it is visualized in red, to indicate that it is not still written in the drive. After every parameter modification, it is necessary to confirm with Enter and to write it in the drive with the "*Write parameter*" command of the "*Parameters*" menu (or with the **Write** W key of the instrument bar).
It's possible to write all parameters of the selected menu using the command "*Write all*" of the menu "*Parameters*" (or using the **Write all** key of the instrument bar).

To speed up the reading and writing operations, the On-line mode is usable, through the suitable command "On line mode" of the menu "*Parameters*" (or using the **On line** key of the instrument bar), the Cockpit instantly updates the parameters values every timethey are selected. Same way it writes instantly on the drive the value of parameters modified by the user.

When parameters have been optimized for the desired operation, the used table can be saved in a file to be copied or used subsequently (command "Save as" on the "File" menù).
The modified data are written directly in the program memory, but being such memory not permanent, the modifications must be saved to avoid to loose them at the system reset. The command "*Save parameters*" of the menu "*Parameters*" (or the **Save** key of the instrument bar), starts the parameters saving in the drive flash memory. The drive will pass to an alarm status of Lock drive shown in the left part of the status bar.

Figure 3.6: Alarm status after parameters saving

After the drive reset, the modified system parameters are fully active and it will possible to test or quickly start the drive calling the Control Panel and enabling the panel inputs, in accord with the planned combinations of the digital and Analog inputs for the "default" operative mode. (see *Table 2.1*).

3.3.3 Control Panel

The Control Panel allows to monitor and control the I/O interface of the drive using the communication line. It can be activated from the configuration tool itself pressing the key related to the instrument bar or from the command "*Control Panel*" of the menu "*Target*". When the first time activated, the "Panel Inputs Enable" option is disabled and the Control Panel acts as a monitor of the current status of the physical I/O.
If the user selects the "Panel inputs enable" option, the drive digital and analog physical inputs are virtually disconnected and the control of the inputs goes to the Control Panel windows.
The "Drive outputs enable" option is activated by default: if disabled the drive physical outputs are disconnected.

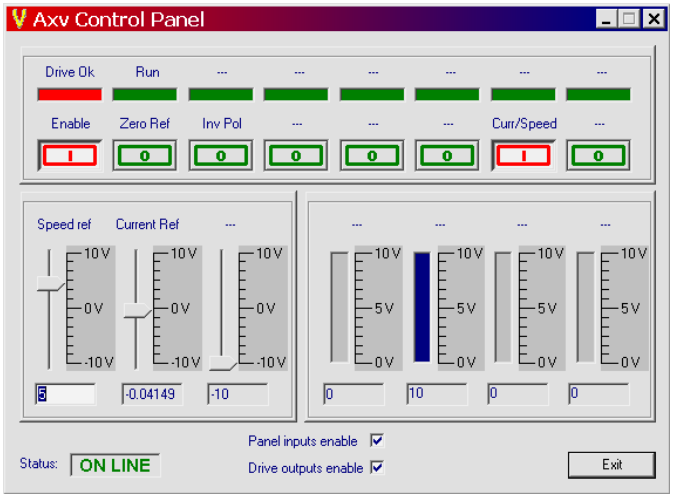


Figure 3.7: Control Panel

3.4 Connections checkout

To verify the motor connections and some parameters value you can use the "monitor page":

In this page you have the DC-link voltage value, the heat-sink temperature and the encoder reading values: position and turn number.
To check the encoder connection: turning clockwise the motor shaft (drive diasbled) you must read a position increment, up to 360 degree. When one turn is completed you must read the initial value in the position number and the initial value +1 in the turn number.
For the drive firmware 65535 virtual pulses are the maximum position value equal to one motor turn.

Moreover there are the values of speed and current limit and reference.

PHASE MOTION CONTROL — AxM — MONITOR PAGE

POWER STAGE					
DC-Link Voltage	304	V	Heat Sink Temperature	26	°C

ENCODER SECTION			
	Main Encoder	Auxiliary Encoder	
Virtual Position	298.38	0	Gradi
Turn Number	45	0	N
Index Position	0	0	Gradi

CURRENT LOOP			Arms
Current Limit	3	Current Reference	0.2

SPEED LOOP			rad / s
Clockwise Limit	199.9	CounterClockwise Limit	199.9
Speed Reference	17.2	Actual Speed	16.1

Figure 3.8: Monitor Page

3.5 Operation monitoring

During the drive operation is useful to control that the drive itself should not be in alarm condition and that the internal variables should be consistent with the system control.
The more simple and intuitive action is surely to monitor the drive status looking to the led displayer referring to the tables 3.1 and 3.2 (paragraph 3.1) for the signals meaning.
If a punctual and deep monitoring action becomes necessary, is useful to connect the drive with the Cockpit configuration tool.
Open from the configuration tool the parameters file (file with extension .par) actually loaded on the drive (in case of first start up the file sys_AxM_01.par). The connection is automatically activated and the drive status is visualized in the left part of the status bar.

Figure 3.9: Communication state

All activated alarms can be visualized by a dedicated windows, opened with the command “Active Alarms” of the “Target” menu or by key on the instruments bar.

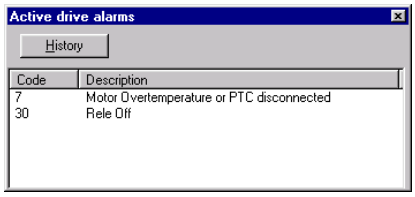
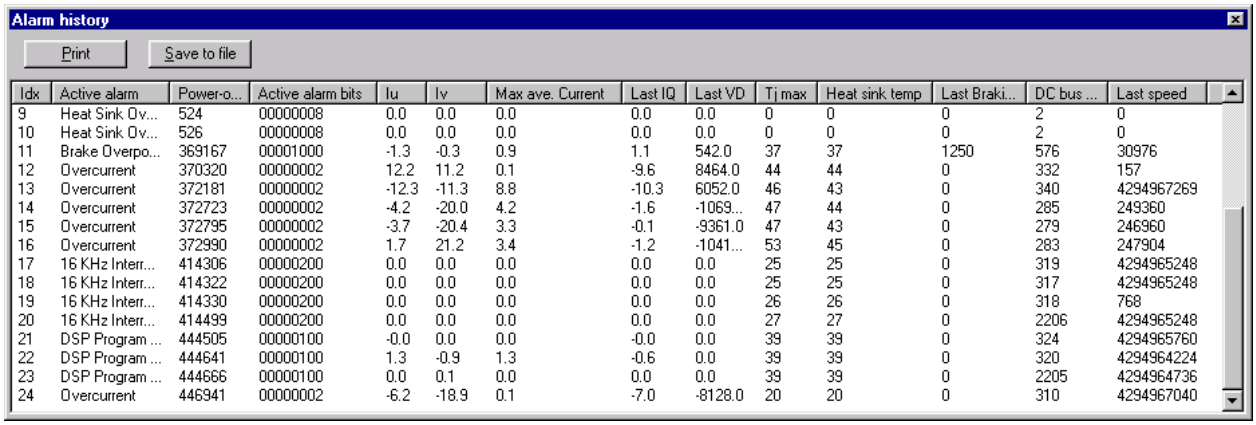


Figure 3.10: Active alarm window

Using the *History* key the “Alarm history” windows is shown: in it are visualized the last 25 alarms occurred, together with the value of some significant variables, at the moment of the alarm intervention. The more recent alarm is shown in the position (Idx) 25. It’s possible to print or save on a file the content of the whole window.



Idx	Active alarm	Power-o...	Active alarm bits	Iu	Iv	Max ave. Current	Last IQ	Last VD	Tj max	Heat sink temp	Last Braki...	DC bus ...	Last speed
9	Heat Sink Ov...	524	00000008	0.0	0.0	0.0	0.0	0.0	0	0	0	2	0
10	Heat Sink Ov...	526	00000008	0.0	0.0	0.0	0.0	0.0	0	0	0	2	0
11	Brake Overpo...	369167	00001000	-1.3	-0.3	0.9	1.1	542.0	37	37	1250	576	30976
12	Overcurrent	370320	00000002	12.2	11.2	0.1	-9.6	8464.0	44	44	0	332	157
13	Overcurrent	372181	00000002	-12.3	-11.3	8.8	-10.3	6052.0	46	43	0	340	4294967269
14	Overcurrent	372723	00000002	-4.2	-20.0	4.2	-1.6	-1069...	47	44	0	285	249360
15	Overcurrent	372795	00000002	-3.7	-20.4	3.3	-0.1	-9361.0	47	43	0	279	246960
16	Overcurrent	372990	00000002	1.7	21.2	3.4	-1.2	-1041...	53	45	0	283	247904
17	16 KHz Interr...	414306	00000200	0.0	0.0	0.0	0.0	0.0	25	25	0	319	4294965248
18	16 KHz Interr...	414322	00000200	0.0	0.0	0.0	0.0	0.0	25	25	0	317	4294965248
19	16 KHz Interr...	414330	00000200	0.0	0.0	0.0	0.0	0.0	26	26	0	318	768
20	16 KHz Interr...	414499	00000200	0.0	0.0	0.0	0.0	0.0	27	27	0	2206	4294965248
21	DSP Program ...	444505	00000100	-0.0	0.0	0.0	-0.0	0.0	39	39	0	324	4294965760
22	DSP Program ...	444641	00000100	1.3	-0.9	1.3	-0.6	0.0	39	39	0	320	4294964224
23	DSP Program ...	444666	00000100	0.0	0.1	0.0	0.0	0.0	39	39	0	2205	4294964736
24	Overcurrent	446941	00000002	-6.2	-18.9	0.1	-7.0	-8128.0	20	20	0	310	4294967040

Figure 3.11: Alarm istory

In addition to the alarm status, the system parameters file makes available a menu “*Monitor*” where is possible to control same internal drive variables, such as: encoder dimensions, speed, requested current, delivered current, etc. The variables are grouped in logic sub-menus. For a detailed descrption refer to the par. 4.

3.6 Firmware upgrading

Firmware upgrades are periodically available on the web site www.phase.it new functionality and/or software evolution, processing from Phase Motion Control laboratories, are fuse and a new firmware version is released.

To upload this, open a *system table* and select "***Load firmware***" from "***Service"*** menù; the follow window will appear:

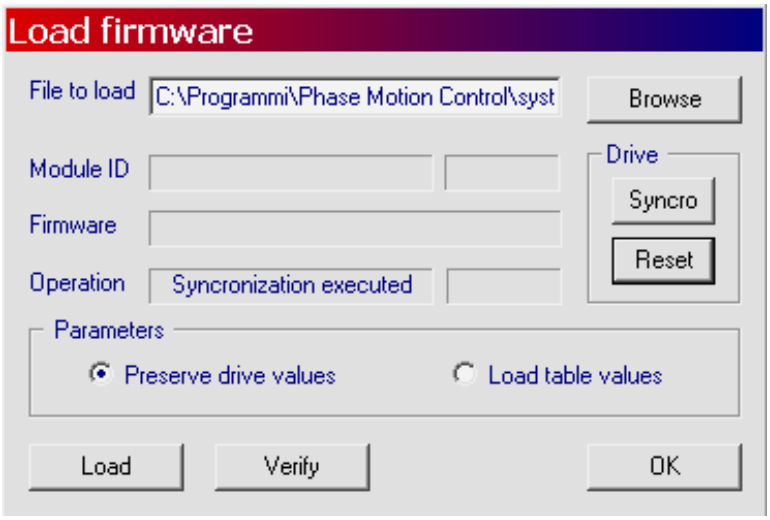


Figure 3.12: Load Firmware and synchronization window

With "***Browse***" button select the firmware file to download (Ex. "**MPIc4_0.sre**").
Press before "***Syncro***" and after "***Reset***" to syncronize the drive.
When "***Syncronization executed***" appear, in the "operation" window press "***Load***" to star the downloading.
At the end of the procedure the drive will be automatically reset.

NOTE:
The drive will be unusable if any troubles occurs during this operation (Ex. Lost of 24V supply, PC connection problem, …). You have to repeat the firmware upload in order to get back the drive working.
If is not possible connecting the drive with the PC, syncronize it pressing "***Syncro***" button, then remove the 24V supply and connect now them.

3.7 Electronic namplate use

The new serial Endat encoder allow to store data in non-valatile mode.
Therefore it is possible to store some parameters with the motor features and execute a coarse configuration based on this parameters.

3.7.1 Plug & play

The "autoset" procedure is executed automatically from AxM drive when the Endat encoder connected has a set of motor parameters unlike with the same parameters stored inside the drive.
In this case the drive upgrade is own set of motor parameters and execute a configuration of some other parameters, like current and speed gains to adapt to the motor.

Here there are all the parameters modified from this procedure.

Drive Parameters	Motor Parameters Menù: Encoders/Monitor/Primary/Endat	
SYS_MOT_N_POLES	*SYS_MOT_POLES*	
SYS_MOT_IDM	*SYS_MOT_I_NOM_ASSE_BLOC x 2*	
SYS_MOT_IN	*SYS_MOT_I_NOM_SPD*	
SYS_ENC1_TYPE	*Endat*	
SYS_IC_P_FAK	*SYS_MOT_INDUTT x 450*	(Ultract)
	2000	(Ul T)
SYS_IC_I_FAK	*SYS_MOT_INDUTT x 225*	(Ultract)
	4000	(Ul T)
SYS_IC_D_FAK	*0*	(Ultract)
	400	(Ul T)
SYS_PHASE_OFFSET	*SYS_ENDAT_FASE*	
SYS_SPL_SPD_FAK	*SYS_MOT_M_INERZ / SYS_MOT_KT x 250*	
SYS_SPL_POS_FAK	*SYS_MOT_M_INERZ / SYS_MOT_KT x 125*	
SYS_RG_POS_SPILM = SYS_RG_NEG_SPILM	*SYS_MOT_NOM_SPD*	
SYS_RG_CW_ACC / DEC = SYS_RG_CCW_ACC / DEC	*SYS_MOT_KT x SYS_MOT_IDM / (SYS_MOT_M_INERZ x 0.1)*	
SYS_SPL_FILT	*0.5*	

Table 3.3: parameters modified by the autosetting procedure

3.7.2 Options

The SYS_PLUG_ENDAT_EN parameter (menù: Encoders/Advanced; par. 4.2.2) allow to start the auto setting procedure independently from the motor parameters.
Setting ON this parameter, saving it and resetting the drive, the firmware will read again the motor features from the encoder and doing again the configuration of the system parameters (table 3.8), leaving SYS_PLUG_ENDAT_EN = OFF;

With the SYS_PLUG_ENDAT_DIS parameter is possible to completely disable the autosettings procedure, also if a new motor is connected.

If is connected a motor with a not configured Endat encoder, the firmware overwrite all the motor parameters to 0 (Menù: Encoders/Monitor/Primary/Endat) but it don't execute any modification of the system parameters. In this case no alarms are segnalized.
If subsequently an auto-configuration is requested, by the SYS_PLUG_ENDAT_EN parameter, the firmware do not execute this procedure and the alarm "Invalid system parameters" is showed. However the SYS_PLUG_ENDAT_EN is resetted by the firmware and after a new drive reset the alarm disappear.

3.8 Test routine use

Selecting SYS_SEL_MODE = Test (Menù "System", par. 4.8) the test routine are enableb. Therefore using the parameters in the "Test" menù it is possible to execute the encoder phasing (in the 2.x firmware only for SINCOS encoder) or the current loop calibration.

The SYS_SEL_TEST parameter allow to select the desired test:

Encoder Phasing → to verify or execute the encoder phasing
Current Loop Calibration → to execute the current loop calibration

3.8.1 Encoder phasing

In this mode the only parameter that could be modified is FAS_CURR (menù: “Test/Encoder Phasing”, paragraph 4.9.1) it limit the current used for during the test. Set it less than the nominal current of the motor.

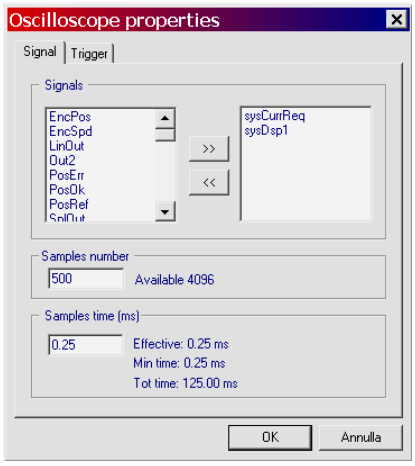
NOTE: To execute correctly thi procedure the motor shaft must be free of load.

The digital input 0 (DI0) enable the drive and it start to supply the motor current, in open loop, up to the encoder index is found. The PH_ERR parameter shows at this point the value of phase error, in degree.
Unlock and move now the encoder position to reduce this value up to 0; values around +/- 2 degree are enough to have a good feedback. Lock again the encoder, disable the drive and move the motor shaft, then do again the same procedure to verify the calibration.

3.8.2 Current loop calibration

To execute the current loop calibration the drive supply two motor phases with a square wave with magnitude and duti-cycle configurable. All this parameters are in the “Test/Current loop calibration” (see paragraph 4.9.2) and are normally setted to have a current request from 0.5A to 1.5A with a 100ms period.

Following we show how have to be setted the internal oscilloscope to see the supplied current and then to execute the calibration.



The “sysCurrReq” variable shoes the currente request; the SYS_SEL_DSP_DATO1 parameter (settable in the menù: Current loop / Advanced settings, see par. **Errore. L'origine riferimento non è stata trovata.**3) shows in this case the real current.

In the right window you can see how set the trigger configuration to start the sampling of the oscilloscope immagine.

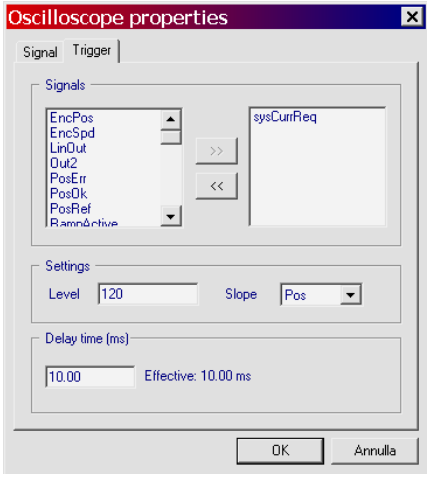


Figure 3.13: Oscilloscope signal settings

Figure 3.14: Oscilloscope trigger settings

Enabling for a while the drive (setting and resetting DI0) the test start and the aquisition it’s shows.

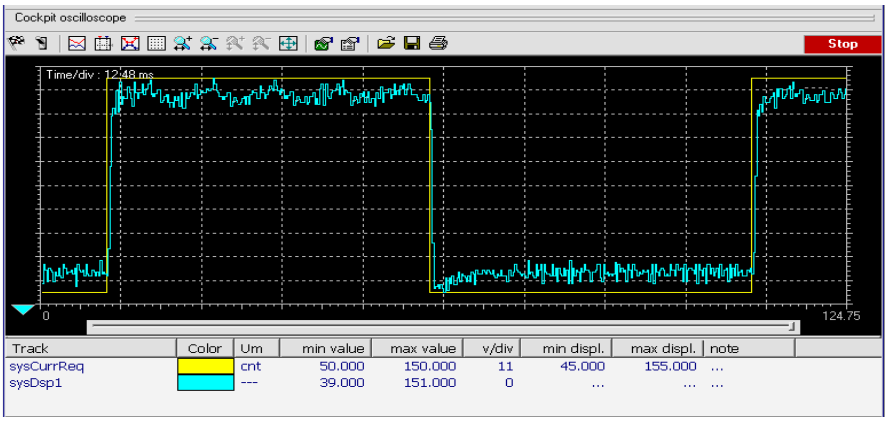


Figure 3.15:Oscilloscope aquisition with request current and real current

The current loop calibration is obtained setting the current loop gain (menù: Current loop; the modification of this parameters are activate when the drive is disable).
See par. 4.3 for the starting set of current gains.

4 SYSTEM PARAMETERS

The system parameters are parameters pre-defined in the drive: then they are present in every application.
They are accessible from Cockpit in the file "sys_AxM_04.par".
They are organized in hierarchical menus and all depend from "**AX_M drive**" menu and can be divided in reading and writing parameters (IPA between 18000 and 20999) and read-only parameters (IPA from 21000 ahead).

NOTE: It's possible to modify the reading-writing parameters by parameters saving.
Generally, unless indicated, the modifications to system parameters will be active at the further system reset (see par. 3.3.2).

Generally the parameters are structured in hierarchic sub-groups collecting all parameters related to the different firmware services.
The sub-groups are in turn divided in logic blocks. Generally there will be some principal sections collecting the more commonly used parameters. Moreover for some services a section called **"Advanced settings"** will be found. The default values set by the manufacturer for these parameters are suitable in most cases. For particular applications only, it can be necessary to set the parameters of this section in order to optimize the drive performances. The user must be aware that the changes introduced assume a very deep knowledge of the details connected to drive firmware and functional control blocks implementation.
Finally, in several sections there is a "**Monitor**" sub-group including all diagnostic parameters allowing to monitor the AxM drive status.

Following the list and description of all system parameters, grouped according to different services, is reported.

4.1 Motor

IPA	Name	Type	Value			Unit of measure
			Default	Min	Max	
18240	SYS_MOT_N_POLES	Word	8	0	100	Nr.
18241	SYS_MOT_IDM	Float	3.00	0.00	100.00	Arms
18242	SYS_MOT_IN	Float	1.00	0.00	100.00	Arms

SYS_MOT_N_POLE: Motor pole number setting.

SYS_MOT_IDM: Motor current limit setting.

SYS_MOT_N_POLES: Motor nominal current setting.

4.2 Encoders

IPA	Name	Type	Value			Value
			Default	Min	Max	
18230	SYS_ENC1_TYPE	Enum *0 Null* *1 Digit* *2 Resolver* *3 Sincos* *4 Hall* *16 Endat*	1 (SinCos)	0 (Absent)	16 (Endat)	---
18231	SYS_ENC1_CY_REV	Word	2048	1	8192	Imp.Enc
18232	SYS_ENC2_TYPE	Enum *0 Null* *1 Digit* *6 Freq*	0 (Absent)	0 (Absent)	1 (Digital)	
18233	SYS_ENC2_CY_REV	Word	1024	1	8192	Imp.Enc
18235	SYS_SE_ENABLE	Bool	Off			---

SYS_ENC1_TYPE: Primary encoder type used for retroaction of the speed/space ring setting.

SYS_ENC1_CY_REV: Primary encoder pulses number per revolution setting. In case of *Resolver, Hall or Endat* set the value 1024.

SYS_ENC2_TYPE: Auxiliary encoder type setting. 0

SYS_ENC2_CY_REV Auxiliary encoder pulses number per revolution setting / Number of simulated pulses of the encoder simulation output, if enabled.

NOTE: In the AxM firmware release 2.0 the number of simulated pulses can be set only on multiple by 2.

SYS_SE_ENABLE Enabling of the encoder simulation on auxiliary encoder port (C1).

4.2.1 Encoders ↳ Index

In the sub-menu "*Encoders – Index* are set the parameters related to the use and control of the index for encoder SinCos or Digital. "

IPA	Name	Type	Value			Value
			Default	Min	Max	
18050	SYS_ENC1_INDEX_ALARM	Bool	Off			---
18060	SYS_ENC2_INDEX_ALARM	Bool	Off			---
18170	SYS_ENC1_INDEX_TOL	Word	2	0	512	CntVi
18171	SYS_ENC2_INDEX_TOL	Word	2	0	512	CntVi

SYS_ENC1_INDEX_ALARM: Enables the "Encoder counting error". If enabled the alarm is issued when the index position reading is different of ± SYS_ENC1_INDEX_TOL from the

position memorized at the first passage on the index. **The parameter change is active without drive resetting.**

SYS_ENC1_INDEX_TOL: Tolerance on the index counting readings, beyond that a drive alarm is generated. (If enabled with SYS_ENC1_INDEX_ALARM). Expressed as virtual counts. **The parameter change is active without drive resetting.**

SYS_ENC2_INDEX_ALARM: Enables the "Auxiliary encoder counting error". If enabled the alarm is issued when the index position reading is different of ± SYS_ENC2_INDEX_TOL from the position memorized at the first passage on the index. **The parameter change is active without drive resetting.**

SYS_ENC2_INDEX_TOL: Tolerance on the index counting readings, beyond that a drive alarm is generated. (If enabled with SYS_ENC2_INDEX_ALARM). Expressed as virtual counts. **The parameter change is active without drive resetting.**

4.2.2 Encoders ↳ Advanced settings

IPA	Name	Type	Value			Name
			Default	Min	Max	
18055	SYS_PLUG_ENDAT_EN	Bool	Off			---
18061	SYS_PLUG_ENDAT_DIS	Bool	Off			---
18163	SYS_PHASE_OFFSET	Word	0	0	65535	CntVi
18200	SYS_RES_ECC_ADJ	Int	35	-30	150	Nr.
18221	SYS_RIP_MAX_FREQ	Float	100	2	1000	kHz
18234	SYS_AD_RIPPLE_LIM	Word	100	0	128	Nr.
18238	SYS_ENC1_INDEX_DISABLE	Bool	Off			---

SYS_PLUG_ENDAT_EN: Enabling of the drive autosetting; based on the motor parameters provided from the endat encoder.
Set this parameter, save and reset the drive; during the start-up cycle the drive will do the autosetting and reset to OFF this parameter.

SYS_PLUG_ENDAT_DIS: Disabling the Plug & Play function for the drive autosetting.
If SYS_PLUG_ENDAT_DIS = OFF the autosetting procedure will be executed every time the values of the SYS_MOT_MODEL + SYS_MOT_TYPE parameters (Menù: *Encoders/Moniror/Primarye/Endat*) are different from the same parameters inside the encoder.
If SYS_PLUG_ENDAT_DIS = ON the autosetting procedure will never be executed.

SYS_PHASE_OFFSET: Field angle correction setting; if a non standard setting is desired.

SYS_RES_ECC_ADJ: Resolver excitation sampling offset setting. By this parameter is possible to change the instant when the Sine and Cosine resolver channels are sampled. The sampling time correction (us) can be obtained by the following formula:

$$T_{offset} = SYS\_RES\_ECC\_ADJ * 0.32us$$

The factory setting aims to sampling optimization in order to get a max. signal/noise (S/N) ratio. However external factors can make necessary a sampling instant fine regulation: modify the parameter to increase the sampled signal amplitude on both resolver channel, in order to optimize S/N. Verify (by oscilloscope window) that the signals "sysResAdc0 / 1" reach the max (1023) and min (0) values without limitations or distortions.
The parameter change is active without drive resetting.

SYS_RIP_MAX_FREQ: Limit value for the frequency of the encoder simulation waves.

SYS_AD_RIPPLE_LIM: Ripple tolerated limit value on encoder Analog channels. Expressed in counts for the Analog-digital converter. The settable values are included between 0 and 128. If the measured ripple would exceed such parameter, the related alarm should activate.

NOTE: Setting 128 on this parameter the "Encoder counting error" alarm will be disable!

SYS_ENC1_INDEX_DISABLE : Disable the index reading, in case of Digital or Sincos encoder.

4.2.3 Encoders ↳ Monitor ↳ Primary

IPA	Name	Type	Unit
21070*	SYS_ENC1_VI_PO	Word	CntVi
21072*	SYS_ENC1_I_VI_PO_MEMO	Word	CntVi
21073*	SYS_ENC1_VI_TU	Long	N°
21078*	SYS_ENC1_I_VI_TU	Long	N°
21110*	SYS_ENC1_I_VI_PO	Word	CntVi
24681*	SYS_ENC1_PE_SP	Long	(CntVi/250us)*2^{16}

SYS_ENC1_VI_PO: Motor position on the turn as read by the primary encoder. Expressed as virtual counts (CntVi).

1 encoder turn = 65535 virtual cnt $\theta[CntVi] = 65536 \cdot \frac{1}{2\pi}\theta[rad]$

SYS_ENC1_VI_TU: Encoder revolution number as read by the primary encoder.

SYS_ENC1_I_VI_PO_MEMO: Position on the revolution of first primary encoder index. Expressed as virtual counts (CntVi). Only for Sincos and Digit encoder.

SYS_ENC1_I_VI_PO: Position on the revolution of first primary encoder index. Expressed as virtual counts (CntVi). Only for Sincos and Digit encoder.

SYS_ENC1_I_VI_TU: Position in turns of the primary encoder first index. Only for Sincos and Digit encoder.

SYS_ENC1_PE_SP: Motor speed as read by the primary encoder. The speed is computed as positions difference (SYS_ENC1_VI_PO) in 250us and extended to 32 bit. The unit of measure is (CntVi/250us)*2exp16.

$$\omega\left[\frac{CntVi}{250\mu s}\cdot 2^{16}\right]\rightarrow\frac{1}{2^{16}}\cdot\frac{2\pi[rad]\cdot 1/250\cdot 10^{-6}[s]}{65536[CntVi]}=\omega\left[\frac{rad}{s}\right]\rightarrow\frac{60[s]}{2\pi[rad]}=\omega[rpm]$$

4.2.3.1 Encoders ↳ Monitor ↳ Primary ↳ Resolver

In this section is possible to monitor the resolver specific parameters.

IPA	Name	Type	Unit
21060*	SYS_RES_ADC_COSE	Word	N°
21061*	SYS_RES_ADC_SINE	Word	N°
21062*	SYS_RES_ABS_COSE	Word	N°
21063*	SYS_RES_ABS_SINE	Word	N°
21064*	SYS_RES_CH_OFF_1	Word	N°
21065*	SYS_RES_CH_OFF_2	Word	N°
21120*	SYS_AD_RIPPLE	Int	N°

SYS_RES_ADC_COSE: Analog level of the cosine channel. Expressed as Analog-digital converter counts.

SYS_RES_ADC_SINE: Analog level of the sine channel. Expressed as Analog-digital converter counts.

SYS_RES_ABS_COSE: Computed cosine value.

SYS_RES_ABS_SINE: Computed sine value.

SYS_AD_RIPPLE: Ripple value on the resolver Analog channels. Expressed as Analog-digital converter counts.

SYS_RES_CH_OFF_1: Offset of the adc resolver channel. Expressed as Analog-digital converter counts.

SYS_RES_CH_OFF_2: Offset of the adc resolver channel. Expressed as Analog-digital converter counts.

4.2.3.2 Encoders ↳ Monitor ↳ Primary ↳ Endat

In this section is possible to monitor the parameters as read by endat among these the electronic nameplate data for drive autocalibration.

IPA	Name	Type	Unit
18401*	SYS_MOT_SERIAL	Dword	N°
18402*	SYS_MOT_DATE	Dword	N°
18403*	SYS_MOT_MODEL	Enum	---
18404*	SYS_MOT_INDUCT	Float	mH
18405*	SYS_MOT_RESIST	Float	ohm
18406*	SYS_MOT_KT	Float	Nm / Arms
18407*	SYS_MOT_I_ZERO_SPD	Float	Arms
18408*	SYS_MOT_I_NOM_SPD	Float	Arms
18409*	SYS_MOT_I_PEAK	Float	Arms
18410*	SYS_MOT_K_TERM	Word	s
18411*	SYS_MOT_INERTIA	Float	mKgm^2
18412*	SYS_ENDAT_PHASE	Word	CntVi
18413*	SYS_MOT_POLES	Word	N°
18414*	SYS_MOT_NOM_SPD	Float	rad / s
18415*	SYS_MOT_TYPE	Dword	---
18430*	SYS_ENDAT_TYPE	Enum	---
18431*	SYS_ENDAT_FORM_DATA	Word	N°
18432*	SYS_ENDAT_TURN_NR	Word	N°
18433*	SYS_ENDAT_TURN_CNT	Word	N°

SYS_MOT_SERIAL_NR Motor serial number.

SYS_MOT_DATA_PROD Manufacturing date. Expressed in the following format:
e.g. 20021218 = Dec 18, 2002.

SYS_MOT_MODEL Motor model.

Code	Model
UL 2	Ultract II
UL 3	Ultract III
UL T	Ultract T

SYS_MOT_INDUTT Value of phase-to-phase motor inductance. Expressed in mH.

SYS_MOT_RESIST Value of phase-to-phase motor resistance. Expressed in ohm.

SYS_MOT_KT Motor torque costant (Kt). Expressed in Nm / Arms.

SYS_MOT_I_NOM_ASSE_BLOC Nominal current with locked shaft (In0). Expressed in Arms.

SYS_MOT_I_NOM_SPD Nominal current at nominal speed (In). Expressed in Arms.

SYS_MOT_I_PICCO Peak current (Ipk). Expressed in Arms.

SYS_MOT_K_TERM Thermal time constant (ta). Expressed in seconds.

SYS_MOT_M_INERZ Inertia moment (Jm). Expressed in Kgm^2.

SYS_ENDAT_FASE Endat phase. Expressed in CntVi.

SYS_MOT_POLES Number of motor poles.

SYS_MOT_NOM_SPD Nominal motor speed (wn). Expressed in rad/s.

SYS_MOT_TYPE Phase Motion Control motor code.
Examples:

Codice Standard Phase	Codice Parametro
UI22.50.5	22505
UI405.30.3	405303
T503.40.3	503403
UI708.15.3	708153

SYS_ENDAT_TYPE Endat type.
M→absolute single-turn (17bit data) N→absolute multi-turn (29bit data)

SYS_ENDAT_FORM_DATA Absolute position bit number.

SYS_ENDAT_NR_GIRI Absolute revolutions number. For multiturn endat only.

SYS_ENDAT_CNT_GIRO Counts per revolution.

4.2.4 Encoders ↳ Monitor ↳ Auxiliary

IPA	Name	Type	Unit
21074*	SYS_ENC2_VI_PO	Word	CntVi
21075*	SYS_ENC2_PE_SP	Long	(CntVi/250us)*2^{16}
21076*	SYS_ENC2_I_VI_PO_MEMO	Word	CntVi
21077*	SYS_ENC2_VI_TU	Long	N°
21079*	SYS_ENC2_I_VI_TU	Long	N°
21111*	SYS_ENC2_I_VI_PO	Word	CntVi

SYS_ENC2_VI_PO: Motor position as read by auxiliary encoder. Expressed in virtual counts (CntVi). 1 turn is 65536 virtual counts as for the main encoder.

SYS_ENC2_VI_TU: Number of encoder turns as read by auxiliary encoder.

SYS_ENC2_PE_SP: Motor rotating speed as read by auxiliary encoder. Speed is computed as positions difference (SYS_ENC2_VI_PO) in 250us and extended to 32 bit. The unit of measure is (CntVi/250us)*2exp16.

SYS_ENC2_I_VI_PO_MEMO: Position on the turn of the first index of the auxiliary encoder. Expressed in virtual counts (CntVi).

SYS_ENC2_I_VI_PO: Position on the turn of the index of the auxiliary encoder. Expressed in virtual counts (CntVi).

SYS_ENC2_I_VI_TU: Position in turns of first index of the auxiliary encoder.

4.3 Current loop

The default configuration of current gains is usually enough for most of the Phase Motion Control motor; to obtain the best performaces use the furmulas in the following table.

IPA	Name	Type	Valore					Unit
			Default	Ideal Value for ***Ultract 2 / 3***	Ideale Value for ***Ultract T***	Min	Max	
18100	SYS_IC_P_FAK	Word	3000	Lw * 450	2000	0	65535	N°
18101	SYS_IC_I_FAK	Word	1500	Lw * 225	4000	0	65535	N°
18102	SYS_IC_D_FAK	Word	0	0	400	0	65535	N°

SYS_IC_P_FAK: Current loop proportional gain. It is actuated when the drive is disabled.

SYS_IC_I_FAK: Current loop integral gain. It is actuated when the drive is disabled.

SYS_IC_D_FAK: Current loop differential gain. It is actuated when the drive is disabled.

You need to reset the drive to activate the modifications of this parameters.

4.3.1 Current loop ↳ Monitor

IPA	Name	Type	Unit
21000*	SYS_DSP_CURR_QUAD	Int	Cnt
21001*	SYS_DSP_CURR_DIR	Int	Cnt
21002*	SYS_DSP_RHO	Word	CntVi
21003*	SYS_DSP_CONTROL	Word	Hex
21004*	SYS_DSP_DATO1	Int	N°
21005*	SYS_DSP_DATO2	Int	N°

21006*	SYS_DSP_DATO3	Word	N°
21007*	SYS_DSP_STATUS	Word	Hex
21100*	SYS_DSP_IU_ANA	Int	Cnt
21101*	SYS_DSP_IV_ANA	Int	Cnt

The parameters with IPA included between 21000 and 21007 have been defined and dedicated to internal use. Only if the drive is enabled, the following parameters have a meaning for the user.

SYS_DSP_CURR_QUAD: Quadrature current reference. Expressed in counts. The conversion factor to obtain current expressed in Arms is 0,01 Arms/cnts. Apply therefore:

Iq = SYS_DSP_CURR_QUAD * 0.01

In speed/position loop such value coincides with the parameter SYS_SPL_W_OUT of the "*Monitor – Speed/Position loop*" sub-menu.

SYS_DSP_CURR_DIR: Direct current reference. Expressed in counts. The conversion factor to obtain current expressed in Arms is 0,01 Arms/cnts. Apply therefore:

Id = SYS_DSP_CURR_DIR * 0.01

It represents the contribution of the direct current that in pasrticular applications is required in the motor phase currents computations.

SYS_DSP_RHO: Field angle**.** Expressed in virtual counts (1 mechanical revolution = 65535 virtual counts). It represents the position on the mechanical revolution, or: $P_{el} = P_{mecc} * N°_{cp}$ where

P_{el} = electric position
P_{mecc} = position on the mechanical revolution (SYS_SPL_VI_PO)
$N°_{cp}$ = motor polar pairs number.

SYS_DSP_IU_ANA: Motor phase U current. Expressed in counts. The conversion factor to obtain current expressed in Arms is 0,00503 Arms/cnts. Apply therefore:

Iu = SYS_DSP_IU_ANA * 0.00503

SYS_DSP_IV_ANA: Motor phase V current. Expressed in counts. The conversion factor to obtain current expressed in Arms is 0,00503 Arms/cnts. Apply therefore:

Iu = SYS_DSP_IV_ANA * 0.00503

4.4 Speed position loop

IPA	Name	Type	Value			Unit
			Default	Min	Max	
18052	SYS_SPL_ERR_MAX_ENABLE	Bool	On			
18150	SYS_SPL_POS_FAK	Word	20	0	32767	N°
18151	SYS_SPL_I_FAK	Word	0	0	32767	N°
18152	SYS_SPL_SPD_FAK	Word	40	0	32767	N°
18154	SYS_SPL_ACC_FAK	Word	0	0	32767	N°
18164	SYS_SPL_POS_ERR_MAX	Word	20000	0	65535	CntVi

SYS_SPL_ERR_MAX_ENABLE: Position error limit enabling. Setting such parameter to On, the position error computed in the speed/position loop will be limited to SYS_SPL_POS_ERR_MAX

SYS_SPL_POS_FAK: Position gain setting: it represents the position error in the speed/position loop multiplication factor. **The parameter change becomes active without drive resetting.**

SYS_SPL_I_FAK: Integral gain setting: it represents the multiplication factor of all contributions of the speed/position loop. **The parameter change becomes active without drive resetting.**

SYS_SPL_SPD_FAK: Speed gain setting: it represents the multiplication factor of the speed error in the speed/position loop. **The parameter change becomes active without drive resetting.**

SYS_SPL_ACC_FAK: Speed differential gain setting. **Still not implemented.**

SYS_SPL_POS_ERR_MAX: Position error limit setting: such parameter is active if the position error limit with the parameter SYS_SPL_ERR_MAX_ENABLE is enabled. Expressed in virtual counts (1 mechanical revolution = 65536 virtual cnt).

This parameter is also useful for limit the supply current when the motor shaft is blocked. Use the following formula to evaluate the supply current:

$$I[Arms] = \frac{\text{SYS\_SPL\_POS\_ERR\_MAX}}{50000} \cdot \text{SYS\_SPL\_POS\_FAK}$$

NOTE: For a complete parameters vision, refer to the block diagram of the speed/position loop, Chapter 11.4 Appendix 4.

4.4.1 Speed position loop ↳ Speed profile

IPA	Name	Type	Value			Unit
			Default	Min	Max	
18054	SYS_RAMP_EN	Bool	On			---
18157	SYS_RG_POS_SPLIM	Float	314.000	---	---	rad/sec
18158	SYS_RG_NEG_SPLIM	Float	314.000	---	---	rad/sec
18159	SYS_RG_CW_ACC	Float	1000.0	---	---	rad/sec^2
18160	SYS_RG_CW_DEC	Float	1000.0	---	---	rad/sec^2
18161	SYS_RG_CCW_ACC	Float	1000.0	---	---	rad/sec^2
18162	SYS_RG_CCW_DEC	Float	1000.0	---	---	rad/sec^2

SYS_RAMP_EN: Speed profile generator enabling. Setting such parameter to Off, speed steps will be generated.

SYS_RG_POS_SPLIM: Max. speed setting, for clockwise motor rotation. Expressed in rad/sec.

SYS_RG_POS_SPLIM: Max. speed setting, for counterclockwise motor rotation. Expressed in rad/sec.

SYS_RG_CW_ACC: Acceleration setting, for clockwise motor rotation. Expressed in rad/(sec*sec).

SYS_RG_CW_DEC: Deceleration setting, for clockwise motor rotation. In rad/(sec*sec).

SYS_RG_CCW_ACC: Acceleration setting, for counterclockwise motor rotation. In rad/(sec*sec).

SYS_RG_CCW_DEC: Deceleration setting, for counterclockwise motor rotation. In rad/(sec*sec).

4.4.2 Speed position loop ↳ Advanced settings

IPA	Name	Type	Value			Unit
			Default	Min	Max	
18053	SYS_SPL_REF_EN	Bool	On			
18057	SYS_SPL_POS_GEN	Bool	Off			
18156	SYS_SPL_FILT	Float	0.300	0.001	1.000	N°
18245	SYS_SPL_SP_IST	Int	2	0	1000	CntVi/250us

SYS_SPL_REF_EN: Flags setting to enabling the input references to the speed/position loop block. Setting this parameter to Off it's possible to set the speed, position and turns references as inputs to the speed/position loop. Normally this parameter must be set to On (Refer to chapter 11.4 Appendix 4).

SYS_SPL_POS_GEN: Enabling this function the speed refence is filtered before enter in the speed/position loop. In this mode is possible to achieve better performances in position applications, above all where a very little overshoot is necessary.

SYS_SPL_FILT: Speed/position loop filtering constant. It represents the time constant of the digital filter implemented in the speed/position loop output. The filtering action changes inversely with the parameter (1.000 = filter excluded, 0.001 max. filtering action).By factory is setting a low filtering action. **Reduce the filter value if a filtering of speed/position loop high frequencies is really useful** (e.g. when a high noise or resolver is present).

SYS_SPL_SP_IST: Speed hysteresis window setting. By this parameter is possible to exclude the contributions of speed variations internal to the hysteresis window in the speed/position loop. As default the hysteresis is deactivated. **Activate the parameter in case of positions and speed particularly jammed by noise** (i.e.: resolver).

4.4.3 Speed position loop ↳ Monitor

IPA	Name	Type	Unit
19018*	SYS_SPL_POS_ERR	Long	CntVi
21040*	SYS_SPL_W_OUT	Int	N°
21041*	SYS_SPL_VI_PO	Word	CntVi

21042*	SYS_SPL_POS_REF	DWord	CntVi*2^{16}
21044*	SYS_SPL_PE_SP	Int	CntVi/250us
21045*	SYS_SPL_PE_SP_REF	Long	(CntVi/250us)*2^{16}
21046*	SYS_SPL_VI_TU	Long	N°
21047*	SYS_SPL_TUR_REF	Long	N°
21049*	SYS_RG_RAMP_IN_CORSO	Bool	--
21052*	SYS_SPL_POS_TUR	Long	CntVi
24683*	SYS_RG_LIN_OUT	Long	(CntVi/250us)*2^{16}

SYS_SPL_POS_ERR: Position error: represents the difference between the theoretical and the actual position. Expressed in virtual counts (CntVi).

SYS_SPL_W_OUT: Speed/position loop output. It represents the current reference output of the speed/position loop.

SYS_SPL_VI_PO: Position on the mechanical turn. Represents the actual position in input of the speed/position loop. Expressed in virtual counts (CntVi) The value of such parameter coincides with SYS_ENC1_VI_PO.

SYS_SPL_POS_REF: Reference position on the mechanical turn. Represents the theoretical position in input of the speed/position loop as computed by the reference generator. Expressed as 32 bit normalized virtual counts (CntVi*2^{16}).

SYS_SPL_PE_SP: Input speed in the speed/position loop. It represents the difference in 250 us between the theoretical position and the actual one. Expressed as virtual counts every 250 us (CntVi/250). Such parameter coincides with the more significant word of the parameter SYS_ENC1_PE_SP in the sub-menu *"Monitor - Encoders"*.

SYS_SPL_PE_SP_REF: Speed reference. It represents the theoretical speed input in the speed/position loop as computed by the references generator. If the profile generator is disabled It coincides with the value of parameter SYS_RG_LIN_OUT of the sub-menu *"Monitor – Speed Profile"*. Expressed in 32 bit normalized counts (CntVi/250*2^{16}).

SYS_SPL_VI_TU: Mechanical revolution number reference in input to the speed/position loop. Such parameters coincides with SYS_ENC1_VI_TU.

SYS_SPL_TUR_REF: Mechanical revolution number reference in input to the speed/position loop as computed by the reference generator.

SYS_RG_RAMP_IN_CORSO: Flag show if the motor is rotating at speed constant (Off) or variable (On).

SYS_SPL_POS_TUR: Actual position expressed as virtual counts (revolutions + position on the turn):

revolution number * 2^{16} + position (CntVi)

SYS_RG_LIN_OUT: Speed reference as computed by the speed profile generator. Expressed in (CntVi/250us)*2^{16}.

For an overall parameters vision, refer to the block diagram of the Ramp generator and the speed/position loop in Chapter 11.4 Appendix 4.

4.5 I/O Configuration

IPA	Name	Type	Value			Unit
			Default	Min	Max	
18244	SYS_REF_IN0	Int	0	---	---	mV
18247	SYS_ REF_IN1	Int	0	---	---	mV

SYS_REF_IN0: Voltage offset setting to be applied to the value read on the analog input number 0. Expressed as mV.

SYS_REF_IN1: Voltage offset setting to be applied to the value read on the analog input number 1. Expressed as mV.

4.5.1 I/O Configuration ↳ Monitor

IPA	Name	Type	Unit
21030*	SYS_ADC_ANA_IN0	Float	V
21031*	SYS_ADC_ANA_IN1	Float	V
21250*	SYS_SP_REF_FAK	Float	(rad/sec) / V
21251*	SYS_I_REF_FAK	Float	Arms / V

SYS_ADC_ANA_IN1: Analog input 1 level. The value is expressed as volt.

SYS_ADC_ANA_IN2: Analog input 2 level. The value is expressed as volt.

SYS_SP_REF_FAK: Input 0 analog reference range. Expressed as (rad/sec) / V computed as ratio between the speed limits and the analog input amplitude, following the formula:

SYS_SP_REF_FAK = MAX (SYS_RG_POS_SPLIM, SYS_RG_NEG_SPLIM) / 10V

The computation is executed every 8ms.

SYS_I_REF_FAK: Input 1 analog reference range. Expressed as (Arms) / V computed as ratio between the current limits and the analog input amplitude, following the formula:

SYS_I_REF_FAK = (SYS_MOT_IDM) / 10V

The computation is executed every 8ms.

4.6 CanOpen

AxM drives are configurable as CANopen standard slave node. All the system parameters are available for configuration and you can select one from some CANopen standard profilles.

IPA	Name	Type	Value			Unit
			Default	Min	Max	
18056	SYS_CAN_EN	Bool	Off			--
18300	SYS_CANOPEN_ENABLED	Bool	Off			--
18316	SYS_CAN_BAUD_RATE	Enum *50* *125* *250* *500* *1000*	500	50	1000	Kbit / s
18317	SYS_NODE	Word	1	1	127	N°

SYS_CAN_EN: Flag setting to activate the hardware CAN port.

SYS_CANOPEN_ENABLED: Flag setting to activate CANopen Communication.

SYS_BAUD_RATE: Setting the communication speed (baudrate).

SYS_NODE: CanOpen line address node setting. For enabled line, the node value must be included between 1 and 127.

WARNING: Do not assign the same CANOpen address to more than one slaves on the net!

4.6.1 CANopen ↳ DS301 Settings

IPA	Name	Type	Value			Unit
			Default	Min	Max	
18375	SYS_GUARD_TIME	Dword	0	0	*	ms
18376	SYS_LIFETIME_FACTOR	Dword	0	0	*	N°

SYS_GUARD_TIME: object 100Ch - "*Guard time*".
Guard time period. Set it to 0 if not used.

SYS_LIFETIME_FACTOR: object 100Dh - "*Life time factor*".
The *Life time factor* multiplied with the *Guard time* gives the *life time* for the *node guarding* procedure. Set it to 0 if not used.

* NOTA: (SYS_GUARD_TIME * SYS_LIFETIME_FACTOR) <= 2^16.

4.6.2 CANopen ↳ DS301 Settings ↳ Sync

IPA	Nome	Tipo	Valore			Unità misura
			Default	Min	Max	
18301	SYS_SYNC_EN_ALR	Bool	Off			---
18374	SYS_SYNC_ADJ	Word	2	0	8	N°
18377	SYS_SYNC_PERIOD	Dword	0	---	---	us
18019*	SYS_SYNC_LOCK	Bool	Off			---

SYS_SYNC_EN_ALR: Enables the alarm related to the synchronization loss with the sync message coming from the master.

SYS_SYNC_ADJ: Correction parameter of the system task execution period for synchronization with the SYNC message coming from master. Each unit means a change of the task period of 320 ns.

SYS_SYNC_PERIOD object 1006h - "*Communication cycle period*".
This object defines the Sync interval in μs. Set it to 0 if not used.

SYS_SYNC_LOCK This variable shows if the drive is syncronized with the master Sync message.
It appears ON if the syncronization is good, else it is OFF.

4.6.3 CANopen ↳ DS301 Settings ↳ Rx PDO 1

IPA	Name	Type	Value			Unit
			Default	Min	Max	
18302	SYS_RXPDO1_TYPE	Enum *sync 1* *rtr 253* *async 254*	*async*			---
18308	SYS_RXPDO1_COBID	Word	000	181h	57Fh	Hex
18318	SYS_RXPDO1_OBJ1_IDX	Word	24640			---
18319	SYS_RXPDO1_OBJ2_IDX	Word	0			---
18320	SYS_RXPDO1_OBJ3_IDX	Word	0			---
18321	SYS_RXPDO1_OBJ4_IDX	Word	0			---
18326	SYS_RXPDO1_OBJ5_IDX	Word	0			---
18327	SYS_RXPDO1_OBJ6_IDX	Word	0			---
18328	SYS_RXPDO1_OBJ7_IDX	Word	0			---
18329	SYS_RXPDO1_OBJ8_IDX	Word	0			---
18350	SYS_RXPDO1_OBJ1_SUB	Word	0			---
18351	SYS_RXPDO1_OBJ2_SUB	Word	0			---

18352	SYS_RXPDO1_OBJ3_SUB	Word	0			---
18353	SYS_RXPDO1_OBJ4_SUB	Word	0			---
18358	SYS_RXPDO1_OBJ5_SUB	Word	0			---
18359	SYS_RXPDO1_OBJ6_SUB	Word	0			---
18360	SYS_RXPDO1_OBJ7_SUB	Word	0			---
18361	SYS_RXPDO1_OBJ8_SUB	Word	0			---

SYS_RXPDO1_TYPE: object 1400.2h - "*PDO 1 transmission type*".
Defines the transmission/reception cheracter of the PDO.

The supported type are:

Transmission type	cyclic	acyclic	synchronous	asynchronous	RTR only
1	x		x		
253				x	x
254				x	

SYS_RXPDO1_COBID: object 1400.1h - "*PDO 1 COB-ID* ".
Defines the CAN identifiers of the PDO.
The default setting is 000; in this mode the COB-ID become the standard CANopen for the present node number:
200h + node ID (SYS_NODE)

SYS_RXPDO1_OBJx_IDX: object 1600.1/8h - "*Parameter index mapped at object x of PDO 1*".
Setting of the index for the variable mapped on the object "x" on PDO 1.
The sub-index from 1 to number of entries contain the information about the mapped application variables.

SYS_RXPDO1_OBJx_SUB: Setting of the sub-index for the variable mapped on the object "x" on PDO 1.

NOTE: The "x" notation designates the object mapped from the PDO1

4.6.4 CANopen ↳ DS301 Settings ↳ Rx PDO 2

IPA	Name	Type	Value			Unit
			Default	Min	Max	
18303	SYS_RXPDO2_TYPE	Enum *sync 1* *rtr 253* *async 254*	*async*			---
18309	SYS_RXPDO2_COBID	Word	000	181h	57Fh	Hex
18322	SYS_RXPDO2_OBJ1_IDX	Word	24640			---
18323	SYS_RXPDO2_OBJ2_IDX	Word	24672			---
18324	SYS_RXPDO2_OBJ3_IDX	Word	0			---
18325	SYS_RXPDO2_OBJ4_IDX	Word	0			---
18330	SYS_RXPDO2_OBJ5_IDX	Word	0			---

18331	SYS_RXPDO2_OBJ6_IDX	Word	0			---
18332	SYS_RXPDO2_OBJ7_IDX	Word	0			---
18333	SYS_RXPDO2_OBJ8_IDX	Word	0			---
18354	SYS_RXPDO2_OBJ1_SUB	Word	0			---
18355	SYS_RXPDO2_OBJ2_SUB	Word	0			---
18356	SYS_RXPDO2_OBJ3_SUB	Word	0			---
18357	SYS_RXPDO2_OBJ4_SUB	Word	0			---
18362	SYS_RXPDO2_OBJ5_SUB	Word	0			---
18363	SYS_RXPDO2_OBJ6_SUB	Word	0			---
18364	SYS_RXPDO2_OBJ7_SUB	Word	0			---
18365	SYS_RXPDO2_OBJ8_SUB	Word	0			---

SYS_RXPDO2_TYPE: object 1401.2h - "*PDO 2 transmission type*".
Defines the transmission/reception cheracter of the PDO.

The supported type are:

Transmission type	cyclic	acyclic	synchronous	asynchronous	RTR only
1	x		x		
253				x	x
254				x	

SYS_RXPDO2_COBID: object 1401.1h - "*PDO 2 COB-ID* ".
Defines the CAN identifiers of the PDO.
The default setting is 000; in this mode the COB-ID become the standard CANopen for the present node number:
300h + node ID (SYS_NODE)

SYS_RXPDO2_OBJx_IDX: object 1601.1/8h - "*Parameter index mapped at object x of PDO 2*".
Setting of the index for the variable mapped on the object "x" on PDO 2.
The sub-index from 1 to number of entries contain the information about the mapped application variables.

SYS_RXPDO2_OBJx_SUB: Setting of the sub-index for the variable mapped on the object "x" on PDO 2.

NOTE: The "x" notation designates the object mapped from the PDO2.

4.6.5 CANopen ↳ DS301 Settings ↳ Rx PDO 3, 4, 5, 6

The required parameters for the configuration of the receiving PDO 3, 4, 5, 6 are the same, therefore we will show following only one schema. We do not show the "*PDO trasmission type*" objects 140(2,3,4,5).2h because this PDOs can be only asynchronous.

IPA	Name	PDO number	Type	Value			Unit
				Default	Min	Max	
18386	SYS_RXPDO3_COBID	3	Word	000	181h	57Fh	Hex

18387	SYS_RXPDO4_COBID	4	Word	000	181h	57Fh	Hex
18388	SYS_RXPDO5_COBID	5	Word	000	181h	57Fh	Hex
18389	SYS_RXPDO6_COBID	6	Word	000	181h	57Fh	Hex

SYS_RXPDO3_COBID:
SYS_RXPDO4_COBID
SYS_RXPDO5_COBID
SYS_RXPDO6_COBID

objects 140(2,3,4,5).1h - "*PDO COB-ID* ".
They define the CAN identifiers of the PDOs numbeo 3,4,5,6.
The default setting is 000; in this mode the COB-ID become the standard CANopen for the present node number:

(400h / 500h / 600h / 700h)+ node ID (SYS_NODE)

IPA				Name	Type
PDO 3	PDO 4	PDO 5	PDO 6		
18680	18688	18696	18704	SYS_RXPDO (3,4,5,6) _OBJ1_IDX	Word
18681	18689	18697	18705	SYS_RXPDO (3,4,5,6) _OBJ2_IDX	Word
18682	18690	18698	18706	SYS_RXPDO (3,4,5,6) _OBJ3_IDX	Word
18683	18691	18699	18707	SYS_RXPDO (3,4,5,6) _OBJ4_IDX	Word
18684	18692	18700	18708	SYS_RXPDO (3,4,5,6) _OBJ5_IDX	Word
18685	18693	18701	18709	SYS_RXPDO (3,4,5,6) _OBJ6_IDX	Word
18686	18694	18702	18710	SYS_RXPDO (3,4,5,6) _OBJ7_IDX	Word
18687	18695	18703	18711	SYS_RXPDO (3,4,5,6) _OBJ8_IDX	Word
18712	18720	18728	18736	SYS_RXPDO (3,4,5,6) _OBJ1_SUB	Word
18713	18721	18729	18737	SYS_RXPDO (3,4,5,6) _OBJ2_SUB	Word
18714	18722	18730	18738	SYS_RXPDO (3,4,5,6) _OBJ3_SUB	Word
18715	18723	18731	18739	SYS_RXPDO (3,4,5,6) _OBJ4_SUB	Word
18716	18724	18732	18740	SYS_RXPDO (3,4,5,6) _OBJ5_SUB	Word
18717	18725	18733	18741	SYS_RXPDO (3,4,5,6) _OBJ6_SUB	Word
18718	18726	18734	18742	SYS_RXPDO (3,4,5,6) _OBJ7_SUB	Word
18719	18727	18735	18743	SYS_RXPDO (3,4,5,6) _OBJ8_SUB	Word

SYS_RXPDO (3,4,5,6) _OBJx_IDX: objects 160(2,3,4,5).1 / 8h - "*Parameter index mapped at object x of PDO*". Setting of the index for the variable mapped on the object "x" on PDO 3,4,5,6.

SYS_RXPDO (3,4,5,6) _OBJx_SUB: Setting of the sub-index for the variable mapped on the object "x" on PDO 3,4,5,6.

NOTE: The "x" notation designates the object mapped from the PDOs.

4.6.6 CANopen ↳ DS301 Settings ↳ Tx PDO 1

IPA	Name	Type	Value			Unit
			Default	Min	Max	
18304	SYS_TXPDO1_TYPE	Enum *sync 1* *rtr 253* *async 254*	*async*			---
18306	SYS_TXPDO1_INHTIME	Word	0			ms
18310	SYS_TXPDO1_COBID	Word	000	181h	57Fh	---
18334	SYS_TXPDO1_OBJ1_IDX	Word	24641			---
18335	SYS_TXPDO1_OBJ2_IDX	Word	0			---
18336	SYS_TXPDO1_OBJ3_IDX	Word	0			---
18337	SYS_TXPDO1_OBJ4_IDX	Word	0			---
18342	SYS_TXPDO1_OBJ5_IDX	Word	0			---
18343	SYS_TXPDO1_OBJ6_IDX	Word	0			---
18344	SYS_TXPDO1_OBJ7_IDX	Word	0			---
18345	SYS_TXPDO1_OBJ8_IDX	Word	0			---
18366	SYS_TXPDO1_OBJ1_SUB	Word	0			---
18367	SYS_TXPDO1_OBJ2_SUB	Word	0			---
18368	SYS_TXPDO1_OBJ3_SUB	Word	0			---
18369	SYS_TXPDO1_OBJ4_SUB	Word	0			---
18378	SYS_TXPDO1_OBJ5_SUB	Word	0			---
18379	SYS_TXPDO1_OBJ6_SUB	Word	0			---
18380	SYS_TXPDO1_OBJ7_SUB	Word	0			---
18381	SYS_TXPDO1_OBJ8_SUB	Word	0			---

SYS_TXPDO1_TYPE: object 1800.2h - "*PDO 1 transmission type*".
Defines the transmission/reception character of the PDO.

The supported type are:

Transmission type	cyclic	acyclic	synchronous	asynchronous	RTR only
1	x		x		
253				x	x
254				x	

SYS_TXPDO1_INHTIME: object 1800.3h - "*PDO 1 Inhibit time*".
Defines the minimum time that as to elapse between two consecutive invocations of a trasmission service for that dato object. Express in ms.

SYS_RXPDO1_COBID: object 1800.1h - "*PDO 1 COB-ID* ".
Defines the CAN identifiers of the PDO.
The default setting is 000; in this mode the COB-ID become the standard CANopen for the present node number:

180h + node ID (SYS_NODE)

SYS_RXPDO1_OBJx_IDX: object 1A00.1/8h - "*Parameter index mapped at object x of PDO 1*".

Setting of the index for the variable mapped on the object “x” on PDO 1.
The sub-index from 1 to number of entries contain the information about the mapped application variables.

SYS_RXPDO1_OBJx_SUB: Setting of the sub-index for the variable mapped on the object “x” on PDO 1.

NOTE: The “x” notation designates the object mapped from the PDO1

4.6.7 CANopen ↳ DS301 Settings ↳ Tx PDO 2

IPA	Name	Type	Value			Unit
			Default	Min	Max	
18305	SYS_TXPDO2_TYPE	Enum *sync 1* *rtr 253* *async 254*	*async*			---
18307	SYS_TXPDO2_INHTIME	Word	0			ms
18311	SYS_TXPDO2_COBID	Word	000	181h	57Fh	---
18338	SYS_TXPDO2_OBJ1_IDX	Word	24641			---
18339	SYS_TXPDO2_OBJ2_IDX	Word	24673			---
18340	SYS_TXPDO2_OBJ3_IDX	Word	0			---
18341	SYS_TXPDO2_OBJ4_IDX	Word	0			---
18346	SYS_TXPDO2_OBJ5_IDX	Word	0			---
18347	SYS_TXPDO2_OBJ6_IDX	Word	0			---
18348	SYS_TXPDO2_OBJ7_IDX	Word	0			---
18349	SYS_TXPDO2_OBJ8_IDX	Word	0			---
18370	SYS_TXPDO2_OBJ1_SUB	Word	0			---
18371	SYS_TXPDO2_OBJ2_SUB	Word	0			---
18372	SYS_TXPDO2_OBJ3_SUB	Word	0			---
18373	SYS_TXPDO2_OBJ4_SUB	Word	0			---
18382	SYS_TXPDO2_OBJ5_SUB	Word	0			---
18383	SYS_TXPDO2_OBJ6_SUB	Word	0			---
18384	SYS_TXPDO2_OBJ7_SUB	Word	0			---
18385	SYS_TXPDO2_OBJ8_SUB	Word	0			---

SYS_TXPDO2_TYPE: object 1801.2h - “*PDO 2 transmission type*”.
Defines the transmission/reception character of the PDO.

The supported type are:

Transmission type	cyclic	acyclic	synchronous	asynchronous	RTR only
1	x		x		
253				x	x
254				x	

SYS_TXPDO2_INHTIME: object 1801.3h - “*PDO 2 Inhibit time*”.
Defines the minimum time that as to elapse between two consecutive invocations of a trasmission service for that dato object. Express in ms.

SYS_RXPDO2_COBID: object 1801.1h - "*PDO 1 COB-ID* ".
Defines the CAN identifiers of the PDO.
The default setting is 000; in this mode the COB-ID become the standard CANopen for the present node number:
280h + node ID (SYS_NODE)

SYS_RXPDO2_OBJx_IDX: object 1A01.1/8h - "*Parameter index mapped at object x of PDO 2*".
Setting of the index for the variable mapped on the object "x" on PDO 1.
The sub-index from 1 to number of entries contain the information about the mapped application variables.

SYS_RXPDO2_OBJx_SUB: Setting of the sub-index for the variable mapped on the object "x" on PDO 1.

NOTE: The "x" notation designates the object mapped from the PDO1.

4.6.8 CANopen ↬ Monitor

IPA	Name	Type	Unit
21200*	SYS_NODE_STATE	Enum *1 Pre operativo* *2 Operativo* *3 Stop*	--
21201*	SYS_FAIL	Word	Hex
21202*	SYS_TXPDO1_LEN	Word	N°
21203*	SYS_TXPDO2_LEN	Word	N°
21204*	SYS_RXPDO1_LEN	Word	N°
21205*	SYS_RXPDO2_LEN	Word	N°
21206*	SYS_RXPDO3_LEN	Word	N°
21207*	SYS_RXPDO4_LEN	Word	N°
21208*	SYS_RXPDO5_LEN	Word	N°
21209*	SYS_RXPDO6_LEN	Word	N°
21220*	SYS_RXPDO1_ACTUAL_COBID	Dword	Hex
21221*	SYS_RXPDO2_ACTUAL_COBID	Dword	Hex
21222*	SYS_RXPDO3_ACTUAL_COBID	Dword	Hex
21223*	SYS_RXPDO4_ACTUAL_COBID	Dword	Hex
21224*	SYS_RXPDO5_ACTUAL_COBID	Dword	Hex
21225*	SYS_RXPDO6_ACTUAL_COBID	Dword	Hex
21226*	SYS_TXPDO1_ACTUAL_COBID	Dword	Hex
21227*	SYS_TXPDO2_ACTUAL_COBID	Dword	Hex

SYS_NODE_STATE: Monitors the node status on the CANopen net. See par. **Errore. L'origine riferimento non è stata trovata.**

SYS_FAIL: Shows the active alarms coded in exadecimal format. With no active alarms it displays 0000. Refer to chapter 11.5 Appendix 5 for a detailed description of all CANopen alarms.

SYS_RXPDO(1,2,3,4,5,6)_LEN: Displays the number of bite exchanged on the receiving PDOs.

SYS_TXPDO(1,2)_LEN: Displays the number of bite exchanged on the transmitting PDOs.

SYS_RXPDO(1,2,3,4,5,6)_ACTUAL_COBID: Displays the receiving PDOs actual COB_ID.

SYS_TXPDO(1,2)_ACTUAL_COBID: Displays the transmitting PDOs actual COB_ID.

4.6.9 CANopen ↳ Device profile DSP402 ↳ Device Control

IPA	Name	Type	Value			Unit
			Default	Min	Max	
6040h	CONTROLWORD	Word	0000	---	---	Hex
6060h	MODE_OF_OPERATION	Enum	Profile Velocity	---	---	---
603Fh*	EMCY_CODE	Word		---	---	Hex
6041h*	STATUSWORD	Word		---	---	Hex
6061h*	MODE_OF_OPERATION_DISPL	Enum		---	---	---

CONTROLWORD: The controlword contains the bits for controlling the state machine and for controlling the specific operating mode.

MODE_OF_OPERATION: This parameter switches the operation mode. The possible values are:

Value	Description
1	Profile position mode
3	Profile velocity mode
128	Torque mode

A read of “modes of operation” shows only the value of the parameter. The present mode of the drive is reflected in the object “modes of operation display” (object6061h.0h).

EMCY_CODE: This object comprises the error register for the drive and e the common status register specific for the manufacturer (manufacturer error register).

STATUSWORD: The statusword indicates the current state of the drive and the current state of the specific operating mode.

MODE_OF_OPERATION_DISPL: The “modes of operation display” shows the current mode of operation. The meaning of the returned value corresponds to that of the modes of operation option code (object 6060h.oh).

All these objects are described at paragraph 6.2.1.

4.6.10 CANopen ↳ Device profile DSP402 ↳ Position Control

IPA	Name	Type	Value			Unit
			Default	Min	Max	
24679	SYS_POS_ERR_WIN	DWord	0	---	---	CntVi
24680	SYS_POS_ERR_TIME	Word	0	---	---	ms

SYS_POS_ERR_WIN: It is the “Position window” object (6067h.0h) that defines a symmetrical range of accepted positions relatively to the “target position”.
If the present value of the position encoder is within the position window, this target position is regarded as reached.
Set (2^32) – 1 to disable this check.

SYS_POS_ERR_TIME: It is the “Position window time” object (6068h.0h). When the present position is within the position window during the defined position window time, the corresponding bit 10 target reached in the statusword will be set to one.
For further information see paragraph **Errore. L'origine riferimento non è stata trovata.**.

4.6.11 CANopen ↳ Device profile DSP402 ↳ Option Codes

IPA	Name	Type	Value			Unit
			Default	Min	Max	
24679	QUICK_STOP_OPT	DWord	Disable drive	---	---	---

QUICK_STOP_OPT**:** This determines what action should be taken if the “Quick stop” function is executed. The action could be one of the following:

Option code	Description
0	Disable drive function
5	Slow down with slow down ramp and stay in quick stop
6	Slow down with quick stop ramp and stay in quick stop

For further information see paragraph 6.2.1.

4.7 CANLink

This feature allows the connection of some AxM by CAN bus interface.
This is a synchronous connection, where the period time is defined by the CANopen object 1006h, "*Communication cycle period*" (SYS_SYNC_PERIOD parameter, IPA 18377, par. 4.6.32) and the data is exchanged by PDOs (see menù for Rx / Tx PDO, par. 4.6.3 and following). The minimum value is 2000us.
On the drive master both SYS_CANLINK_EN and SYS_CAN_EN (4.6.3) parameters must be set to enable the CANLink interface; to exchange data all the available PDOs are configurable (2 Tx PDO and 6 Rx).
On the slaves the parameters SYS_CAN_EN and SYS_CANOPEN_ENABLED must be set and one Rx PDO has to be configured corresponding to the Tx PDO master. Moreover a number of Tx PDO are configurable dependig on the number of slaves connected on the net. If 3 slaves (or less) are connected it is possible to configure 2 Tx PDO on every slave, else if 6 slaves are connected only one Tx PDO could be configured on every slave.
To configure the PDOs the COB-ID and the object to read or write have to be set different from 0, but it's not necessary follow the CANopen rules. If the COB-ID is 0 the PDO is disabled.
All the other CANopen parameters like "*PDO transmission type*" and *PDO Inhibit time*" are not used.

Moreover the others following parameters has to be configured:

IPA	Name	Type	Value			Unit
			Default	Min	Max	
18058	SYS_CANLINK_EN	Bool	Off			---
18059	SYS_CANLINK_ALARM_EN	Bool	Off			---
21240*	CL_STATE	Enum *0 Non attivo* *1 Sincronizzazione slaves* *2 Run* 3 *Error*				---
21241*	CL_ERROR	Word				---
21242*	CL_N_SLAVE	Word				N°

SYS_CANLINK_EN: CANLink interface enable on the drive master.

SYS_CANLINK_ALARM_EN: Enable the net alarms management.

CL_STATE: CANLink state.

CL_ERROR: CANLink active error code.

Code	Name	Descriptiones
0x0000	CL_E_OK	Drive Ok
0x0001	CL_E_SYSTEM	Systema error
0x0002	CL_E_PERIOD	Period configuration error
0x0004	CL_E_BUSOFF	CANLink Bus-off
0x0008	CL_E_LINE_WRONG	CAN hardware error
0x0010	CL_E_SLAVE_LOST	Communication lost with one slave
0x0100	CL_E_CFG_MASTER	Master configuration error
0x0200	CL_E_CFG_SLAVE	Slave configuration error

CL_N_SLAVE: Number of active slaves; this value depend on the specific configuration.

4.7.1 CANLink ↯ Master

IPA	Name	Type	Value			Unit
			Default	Min	Max	
8200*	CLM_WORD1	Word	0	---	---	---
8201*	CLM_WORD2	Word	0	---	---	---
8202*	CLM_WORD3	Word	0	---	---	---
8203*	CLM_WORD4	Word	0	---	---	---
8204*	CLM_WORD5	Word	0	---	---	---
8205*	CLM_WORD6	Word	0	---	---	---
8206*	CLM_WORD7	Word	0	---	---	---
8207*	CLM_WORD8	Word	0	---	---	---

CLM_WORD(1,2,3,4,5,6,7,8): Display of the master data.

4.7.2 CANLink ↯ Slave 1, 2, 3, 4, 5, 6

IPA						Name	Type	Unit
21244*	21245*	21246*	21247*	21248*	21249*	CLS(1,2,3,4,5,6)_STATE	Enum *0 Disconnect* *1 Connect*	---
8216*	8220*	8224*	8228*	8232*	8236*	CLS(1,2,3,4,5,6)_WORD1	Word	---
8217*	8221*	8225*	8229*	8233*	8237*	CLS(1,2,3,4,5,6)_WORD2	Word	---
8218*	8222*	8226*	8230*	8234*	8238*	CLS(1,2,3,4,5,6)_WORD3	Word	---
8219*	8223*	8227*	8231*	8235*	8239*	CLS(1,2,3,4,5,6)_WORD4	Word	---

CLS(1,2,3,4,5,6)_STATE: Slaves status: Not connected → 0, Connected → 1;

CLS(1,2,3,4,5,6)_WORD1: Display of the slaves data.

4.8 System

IPA	Name	Type	Unit of measure
18051	SYS_SEL_MODE	Enum *0 Default* *1 Remote* *2 Plc* 3 *Test*	Default

SYS_SEL_MODE: Operating mode setting:

Default → default mode operation (see par. 2.1).

Remote → CANopen mode operation; the drive become a standard CANopen slave node and it is possible to control it by a remote master (see chapter 6).

PLC → operation with PLC application; enable the specific PLC application downloaded inside the drive. If no application was previously downloaded the alarm "application not loaded" is showing. (see paragraph 2.2 and chapter 8)

Test → enable the tests routine; with this option it is possible to execute the current loop calibration or the encoder phasing (see par. 3.8)

4.8.1 System ↳ Braking unit

IPA	Name	Type	Value				Unit
			Taglia	Default	Min	Max	
18106	SYS_R_BRAKE	Word	**04 09 4**	70	60	80	ohm
			06 14 4	42	38	50	
			09 20 4	30	26	34	
18107	SYS_P_BRAKE_MAX	Word		10			W
18108	SYS_OV_CLM_LIM	Word		800			V

SYS_R_BRAKE: Braking resistor value. The default value matches the drive internal resistance. This value is used by the firmware to calculate the braking power consuption; if an external brake resistor is used set here a new value.

SYS_P_BRAKE_MAX: Maximum power wasted by the braking resistor. Defines the edge limit of the "Brake overpower" alarm. No more than 10 W by the internal resistance.

SYS_OV_CLM_LIM: Braking resistor clamping voltage.

4.8.2 System ↳ Serial

IPA	Name	Type	Value			Unit
			Default	Min	Max	
18140	SYS_BAUD_RATE	Enum *0 1200* *1 2400* *2 4800* *3 9600* *4 14400* *5 19200* *6 38400*	6 (38400)	0 (1200)	6 (38400)	bps
18141	SYS_SER_MODE	Enum *0 8,N,1* *1 8,O,1* *2 8,E,1* *3 8,N,2* *4 8,O,2* *5 8,E,2*	0 (8,N,1)	0 (8,N,1)	5 (8,E,2)	
18142	SYS_SER_DELAY_TIME	Word	0	0	800	msec
18143	SYS_MOD_ADDR	Word	0	0	0	N°

SYS_BAUD_RATE: Drive serial communication (baudrate) setting. The preset value is 38400.

SYS_SER_MODE: Serial port configuration setting. Selectable values are following:
8,N,1 (no parity, 8 data bit, 1 bit di stop)
8,O,1 (odd parity, 8 data bit, 1 bit di stop)
8,E,1 (even parity, 8 data bit, 1 bit di stop)
8,N,2 (no parity, 8 data bit, 2 bit di stop)
8,O,2 (odd parity, 8 data bit, 2 bit di stop)
8,E,2 (even parity, 8 data bit, 2 bit di stop)
The factory value is 8,N,1.

SYS_MOD_ADDR: Modbus address setting.

If one of the previous parameters is modified it becomes necessary to align the setting of the Cockpit configuration tool PC serial (menu "*Target - Communication settings*") and of GPLC development ambience (menu: "*Communication - settings*") in order to avoid communication problems with the drive. Refer to par. 3.3.1 for further details.

SYS_SER_DELAY_TIME: Setting of minimum delay between the reception by the drive of the last byte and the beginning of its answer. Such delay avoids conflicts on the serial line when the RS232 interface is not scheduled for an automatic commutation TX/RX. **The parameter modification is active without resetting the drive.**

4.8.3 Sistema ↳ Advanced

IPA	Name	Type	Value			Unit of measure
			Default	Min	Max	
18103	SYS_SEL_DSP_1	Enum *10 Iu_Ana* *11 Iv_Ana* *20 VdcBus* *50 Heat_Temp* *59 Ct_Isd* *60 Ct_Isq* *62 Ct_Vsu* 63 *Ct_Vsv*				---
18104	SYS_SEL_DSP_2	Word				Hex
18109	SYS_OV_K_FILT	Word	1000	0	100000	N°
18110	SYS_OV_K_FRHO	Word	128	0	256	N°
18114	SYS_SPEED_DEF	Word	200	--	--	N°
18115	SYS_ANGLE_DEF	Word	5	--	--	N°
18220	SYS_RIP_CORR_FATT	Word	2	1	100	N°

SYS_SEL_DSP_DATO1: Selection Parameter for the first Dsp variable to be shown on the oscilloscope, chosen among the list of proposed variables.

SYS_SEL_DSP_DATO2: Selection Parameter for the second Dsp variable to be shown on the oscilloscope: selected though memory address.

Variabile	Indirizzo
Iu_Ana	241
Iv_Ana	242
VdcBus	26E
Heat_Temp	320
Ct_Isd	250
Ct_Isq	251
Ct_Vsu	267
Ct_Vsv	268

SYS_OV_K_FILT: Time constant of the feed-forward filter value.

SYS_OV_K_FRHO: Value of the feed-forward angle.

SYS_SPEED_DEF: Speed limit for defluxing algoritm **(not yet active)**

SYS_ANGLE_DEF: Angle value for defluxing algoritm **(not yet active)**

SYS_RIP_CORR_FATT: Encoder corrective repetition factor setting. The parameter allows to modify the weight of the feedforward contribution at low speeds. Increasing the value, the drive operates in a less impulsive mode correcting the position error at low speeds. The factory supplied value generally allows to obtain corrected repetition at all speeds. **For repetitions at extremely low speeds it could be advisable to increase the parameter value.**

4.8.4 System ↳ Monitor

IPA	Name	Type	Unit
21102	SYS_DSP_VDC_BUS	Volt	N°
21103	SYS_SPL_MOD_TEMP	°C	N°
21210	SYS_PTC_TEMP	Word	N°

SYS_DSP_VDC_BUS: Dc-Bus voltage after the rectifier bridge. Expressed as Volt.

SYS_SPL_MOD_TEMP: Power module temperature. Expressed as °C.

SYS_PTC_TEMP: Motor temperature as read by PTC. Expressed as Analog-digital converter counts.

4.8.5 System ↳ Alarms

In the “Alarms” sub-menu, all informations related to the drive alarm condition are reported.

IPA	Name	Type	Unit
18030	SYS_ALARM_MASK	DWord	Hex
19028	SYS_EMERGENCY_CODE	Word	Hex

SYS_ALARM_MASK: Mask of the drive active alarms. Refer to paragraph **11.1** Appendix 1 for a full alarms description.

SYS_EMERGENCY_CODE: Code of the highest priority active alarm in accord with the DSP-402 specification. Refer to the Appendix 1 for a full alarms description.

4.9 Test

IPA	Name	Type	Unit
24000	SYS_SEL_TEST	Enum *0 Current loop calibration* *1 Encoder phasing*	---

SYS_SEL_TEST: Select the operation modality.

4.9.1 Test ↳ Encoder phasing

IPA	Name	Type	Default	Unit
24010	FAS_CURR	Float	1	Arms
24011*	PH_ERR	Float		°mec
24012*	SPL_RHO_SIM	Word		CntVi
24013*	TEST_ERR	Enum *0 Ok* *1 Motor shaft blocked* *2 Wrong direction* *3 Wrong poles number* *4 Run* *5 Disabled*		---

FAS_CURR: Value of current used for the phasing procedure.

PH_ERR: Correction angle from the right position and the actual position of the encoder.

SPL_RHO_SIM: Position of simulated field angle as generated by the firmaware.

TEST_ERR: Test status.

4.9.2 Test ↳ Current loop calibration

IPA	Name	Type	Default	Unit
24001	TG_CYC	Word	50	2 ms
24002	TG_I_HIGH	Float	1.5	Arms
24003	TG_I_LOW	Float	0.5	Arms

TG_CYC: Square vawe period.

TG_I_HIGH: Upper value of the request current. Expressed in Arms.

TG_I_LOW: Lower value of the request current. Expressed in Arms.

5 STANDARD DS 301

The CANopen protocol is one of the most common CAN protocols. Since 1995 the CANopen specification is handed over to CAN in Automation (CiA) international users and manufacturers group. The European standardization authorities have accepted the CANopen Device Specification version 4.01 as EN 50325-4. The main concept of CANopen is based on use of an object dictionary (basically device's variables, parameters, etc.). This dictionary gathers data related to the communication and the application. To access to these objects two methods are used: SDO & PDO.

SDO mean Service Data Object and is a confirmed way to exchange data of the object dictionary between master and slave. Usually a slave device is an SDO server, this mean that it could answer to a query originated by an SDO client, typically the master device of the network. Usually this protocol is used to configure the internal parameters of the device; in the Tw Motor it is used also to upgrade the firmware wherever necessary. The confirmed nature of this protocol generate a large amount of traffic on the CAN bus making it unsuitable for high-speed real-time communication.

The PDO (Process Data Object) is an unconfirmed way and extremely configurable protocol to exchange high-speed real-time data, maximizing advantages of the CAN architecture. The transfer of PDOs is performed with no protocol overhead. The PDOs correspond to entries in the device Object Dictionary and provide the interface to the application objects. Data type and mapping of application objects into a PDO is determined by a corresponding PDO mapping structure within the Device Object Dictionary. Basically a PDO could be asynchronous (means that the transmission is triggered on a specific event or is remotely requested) or synchronous (means that the transmission is synchronized with the Synchronization Object).

The SYNC producer, typically the master, broadcasts the Synchronization Object periodically. This SYNC provides the basic network clock. There can be a time jitter in transmission by the SYNC producer corresponding approximately to the latency due to some other COB being transmitted just before the SYNC. In order to guarantee timely access to the CAN bus the SYNC is given a very high priority identifier.

Emergency objects are triggered by the occurrence of a device internal error situation and are transmitted from an emergency producer (typically the slave) on the device. Emergency objects are suitable for interrupt type error alerts.

The Network Management (NMT) is node oriented and follows a master-slave structure. NMT objects are used for executing NMT services. Through NMT services, nodes are initialized, started, monitored, reset or stopped. All nodes are regarded as NMT slaves. An NMT Slave is uniquely identified in the network by its node-ID, a value in the range of [1..127]. NMT requires that one device in the network fulfils the function of the NMT Master.

Standard features that are implemented in AxM drive are:

NMT	Slave
Server SDO	1
Tx PDO	2 (fully programmable)
Rx PDO	2 (fully programmable) + 4 (asyncrhonous only)
PDO Mapping	User programmable (only in "pre-operational" state)
PDO Modes	Supported type: 1, 253 e 254
Emergency object	Yes
Sync object	Yes
Time object	No
Error control protocols	Node Guarding

Table 5.1: AxM CANopen features

5.1 Object Dictionary

The most important part of a device profile is the Object Dictionary description. The Object Dictionary is essentially a grouping of objects accessible via the network in an ordered pre-defined fashion. The overall layout of the standard Object Dictionary is shown below. This layout closely conforms to other industrial serial bus system concepts:

Index	Object
0000h-0FFFh	data definition / reserved
1000h-1FFFh	communication profile area (DS301)
2000h-5FFFh	Manufacturer specific area (AxM drive specific)
6000h-9FFFh	standardized device profile area (DSP402)
A000h-FFFFh	other profiles / reserved

Table 5.2: Object dictionary layout

For further information refer to Phase Motion Control TW motor software manual.

5.2 SDO and PDO

With Service Data Objects (SDOs) the access to entries of a device Object Dictionary is provided. As these entries may contain data of arbitrary size and data type, SDOs can be used to transfer multiple data sets. The contents of the data set are defined within the Object Dictionary.

If transfer would fail for some reason, both master and slave could send the **abort transfer** COB (it could be sent in any download/upload segment):

Abort transfer (Master → Slave or Slave → Master)

COB-ID	B0	B1	B2	B3	B4	B5	B6	B7
600h+node-ID or 580h+node-ID	80h	index		subidx	abort code			

The **abort code** could be one of the following:

Abort code	Description
0503 0000h	SDO toggle bit not alternated during segmented transfer.
0504 0000h	SDO protocol timed out.
0504 0001h	SDO client/server command specifier not valid or unknown.
0601 0000h	Unsupported access to an object.
0601 0001h	Attempt to read a write only object.
0601 0002h	Attempt to write a read only object.
0602 0000h	Object does not exist in the object dictionary.
0604 0041h	Object cannot be mapped to the PDO.
0604 0042h	The number and length of the objects to be mapped would exceed PDO length.
0606 0000h	Access failed due to an hardware error of the internal non-volatile storage.
0607 0010h	Data type does not match, length of service parameter does not match.
0607 0012h	Data type does not match, length of service parameter too high.
0607 0013h	Data type does not match, length of service parameter too low.
0609 0011h	Sub-index does not exist.
0609 0030h	Value range of parameter exceeded (only for write access).
0609 0031h	Value of parameter written too high.
0609 0032h	Value of parameter written too low.
0800 0000h	General error.
0800 0020h	Data cannot be saved or restored from the internal non-volatile storage, wrong signature.

Abort code	Description
0800 0021h	Data cannot be saved or restored from the internal non-volatile storage because of local control.
0800 0022h	Data cannot be transferred or stored to the application because of the present device state.

Table 5.3: Abort code

Process Data Objects (PDOs) are used to transmit any process data for the process control. The PDOs are transmitted in broadcast and without any confirmation back to the transmitting device. There are two kinds of use for PDOs. The first is data transmission and the second data reception. It is distinguished in Transmit-PDOs (TPDOs, from slave to master) and Receive-PDOs (RPDOs, from master to slave).
Synchronous PDOs are transmitted on SYNC event and could be cyclic (means that the transmission is every n SYNC, with n between 1 and 240), acyclic (means that the transmission is triggered on event and then synchronized with SYNC event) or RTR-Only (only for TPDOs, means that master request the transmission by sending an RTR COB with same COB-ID of the specific TPDO). The received RPDOs data is internally processed on the SYNC event, not immediately after receiving RPDO itself. The transmitted TPDOs data is sampled on the SYNC event, not at the time of transmission. TPDOs are dispatched immediately after the SYNC event, while RPDOs normally are dispatched from the master after all TPDOs and just before next SYNC event.
Asynchronous TPDOs could be triggered on event (means on changing data) or RTR-Only (means that master request the transmission by sending an RTR COB with same COB-ID of the specific TPDO). It is not guaranteed that the time on which data change and the time the TPDO are transmitted are the same. The received data of the asynchronous RPDOs are internally dispatched as soon as possible.
TPDOs could also have enabled the RTR allowed attribute, this means that, disregarding the transmission type, the master has the possibility to force the transmission by RTR COB.
Examples:

RPDO #1: controlword (16 bit) and target position (32 bit):

COB-ID	B0	B1	B2	B3	B4	B5
200h+node-ID	6040h.0h		607Ah.0h			

TPDO #2: statusword (16 bit) and mode of operation display (8 bit):

COB-ID	B0	B1	B2
280h+node-ID	6041h.0h		6061h.0h

In the AxM drive it is possible to change the COB-ID (independently from the node-ID), the data mapping (for all PDOs) and specify an **inhibit time** (valid only for asynchronous TPDOs), that defines the minimum time that has to elapse between two consecutive invocations of a transmission service for that TPDO.

For all PDOs configuration there are specific entries in the object dictionary: 1400h e 1600h for RPDOs, 1800h e 1A00h for TPDOs.

5.3 SYNC

The Synchronization Object does not carry any data and is unconfirmed service.

Sync COB (broadcast):

COB-ID
080h

This object trigger the internal parameters exchange to and from all synchronous PDO buffers.

AxM also use the SYNC object to synchronize his internal machine cycle with that of the Synchronization Object producer, but only if the SYNC cycle time is multiple of 250μs, see paragraph 4.6.2.

5.4 EMCY

AxM support the emergency object. An emergency object is transmitted only once per 'error event'.

Emergency COB (broadcast):

COB-ID	B0	B1	B2	B3	B4	B5	B6	B7
080h+node-ID	error code		error register	AxM error register				reserved

error code: *0000h – drive ok; 1000h – generic alarm*
standard CiA error code (object 603Fh.0h)

error register: *0h – drive ok; 1h – generic alarm*
standard CiA error register (object 1001h.0h)

AxM error reg.: *AxM active alarm mask "*sysData_EmergencyCode*", mapped in the manufacturer status register (object 1002h.0h)*

AxM manage only the "generic error" for "error code" (vedi anche oggetto 603Fh.oh, par. 6.2.1) and "error register" field; in the AxM error registe the active alarm mask "*sysData_EmergencyCode*" is showed.

Error register bit		Error code	
Bit	**Meaning**	**Error code (hex)**	**Meaning**
-	No error	0000	No error
0	Generic error	1000	Generic error
1	Current	2000	Current
2	Voltage	3000	Voltage
3	Temperature	4000	Temperature
4	Communication error	5000	Hardware
5	device profile specific	6000	Software
7	manufacturer specific	7000	Additional modules

Table 1.4: Error register and Error code

5.5 NMT

The NMT object are shared into two categories.

5.5.1 Module control services

Through Module Control Services, the NMT master controls the state of the NMT slaves. The state attribute is one of the values {STOPPED, PRE-OPERATIONAL, OPERATIONAL, INITIALISING}. The Module Control Services can be performed with a certain node or with all nodes simultaneously.

NMT COB

COB-ID	B0	B1
000h	CS	node-ID

CS: 01h: **start** remote node
02h: **stop** remote node
80h: enter **pre-operational** remote node
81h: **reset** remote node
82h: **reset communication** of remote node

Node-ID: Node-ID of the remote node or 00h for broadcast to all nodes

Immediately after power-on the node enter in the PRE-OPERATIONAL state; then master could follow these steps to set-up the nodes before enabling them to the OPERATIONAL state:
Configuration of all device parameters, including communication parameters (via Default SDO)

start transmission of SYNC, wait for synchronization of all devices
Start of Node Guarding

All of those operations are optional as AxM support full parameters saving to internal non-volatile storage and the requirement of SYNC depend from the specific application.

State transitions are caused by reception of an NMT COB used for module control services or an hardware reset.

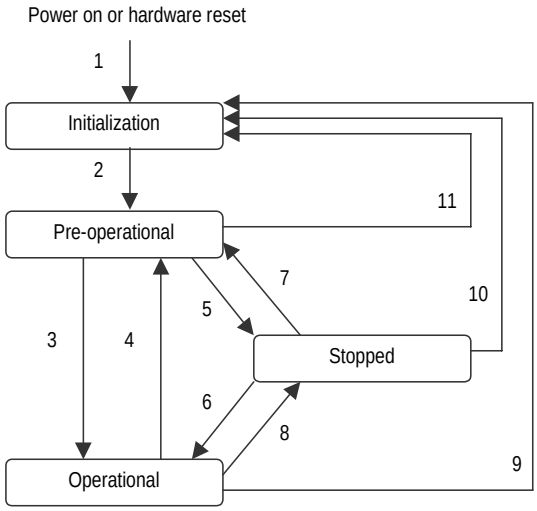


Figure 5.1: State diagram of a device

1	At Power on the initialization state is entered autonomouslv
2	Initialization finished - enter pre-operational automatically
3,6	Start remote node
4,7	Enter pre-operational remote node
5,8	Stop remote node
9,10,11	Reset remote node / Reset communication of remote node

Table 5.5: Trigger for state transition

	INITIALISING	PRE-OPERATIONAL	OPERATIONAL	STOPPED
PDO			X	
SDO		X	X	
SYNC		X	X	
EMCY		X	X	
Network Management Objects		X	X	X

Table 5.6: NMT states and defined communication objects

5.5.2 Error control protocols

Through Error control services the NMT detects failures in the network. Local faults in a node may lead to a reset or change of state. Error Control services are achieved principally through periodically transmitting of COBs by a device. There exist two possibilities to perform Error Control, the Guarding and the Heartbeat, but only the first is managed by AxM.

Node Guarding Protocol: The NMT Master polls (with an RTR COB with same COB-ID of the Error Control COB) each NMT Slave at regular time intervals. This time-interval is called the guard time and may be different for each NMT Slave. The response of the NMT Slave contains the state of that NMT Slave. The

node life time is given by the guard time (object 100Ch.0h) multiplied by the life time factor (object 100Dh.0h). The node life time can be different for each NMT Slave. If the NMT Slave has not been polled during its life time, it issues an EMCY object with error code 8130h and then the action indicated in the Abort Connection (object 6007h.0h) is issued. The error is cleared either restarting polling slave or by a reset node / reset communication command (see also par. 4.6.1).

Error Control COB

COB-ID	B0	
700h+node-ID	7 r	6..0 s

t: used only with the **Node Guarding Protocol**, it toggle between 0 and 1 every time the COB is sent (the first time after boot-up or reset node / reset communication command is 0); other ways is 0

s: 00h: Bootup 04h: Stopped
05h: Operational 7Fh: Pre-Operational

6 STANDARD DSP 402

The purpose of this profile is to give drives an understandable and unique behavior on the CAN bus. The purpose of drive units is to connect axle controllers or other motion control products to the CAN bus.
The two principal advantages of the profile approach for device specification are in the areas of system integration and device standardization.
A device profile defines a 'standard' device. This standard device represents really basic functionality, every device within this device class must support. This mandatory functionality is necessary to ensure, that at least simple non-manufacturer-specific operation of a device is possible.
Following are presented the DSP-402 profile objects implemented in the AXM drive. For the emergency codes refer to paragreph 11.1 Appendix 1.

6.1 Drive architecture

The basic architecture is composed of two main modules:

- **Device Control**: the state machine executes the starting and stopping of the drive and several mode specific commands.
- **Modes of Operation**: The operation mode defines the behavior of the drive. The following modes are defined in this profile:
    1. **Profile position mode**: The positioning of the drive is defined in this mode. Speed, position and acceleration can be limited and profiled moves using a Trajectory Generator are possible as well.
    2. **Profile velocity mode**: The Profile Velocity Mode is used to control the velocity of the drive with no special regard of the position. It supplies Trajectory Generation.
    3. **Interpolated position mode**: This mode allow the time interpolation of single axes and the spatial interpolation of coordinated axes.
    4. **Torque mode**: The user could drive the motor feeding torque reference (current reference); please note that this is not the same as the standard **Profile torque mode**, but Tw Motor specific.

AxM support switching between the various modes of operation, only through the "switched on" state.

6.2 Device Control

The device control function block controls all functions of the drive (drive function and power section). The state of the drive can be controlled by the controlword (object 6040h.0h) and is shown in the statusword (object 6041h.0h). The state machine is also controlled by internal signals like faults.

State	Statusword	Description
Not Ready to Switch On	xxxx xxxx x0xx 0000	The drive is being initialized, then is not ready to accept command and the power output is disabled
Switch On Disabled	xxxx xxxx x1xx 0000	AxM initialization is complete, then is ready to accept command, the power output and the drive functions are disabled
Ready To Switch On	xxxx xxxx x01x 0001	The drive functions are disabled, the drive is ready to enable power output
Switched On	xxxx xxxx x01x 0011	The drive functions are disabled, the drive has power output enabled, the motor shaft has no torque
Operation Enable	xxxx xxxx x01x 0111	The drive functions and power output are enabled, the torque could be applied on the motor shaft, no faults detected, specific selected Mode Of Operation is executed
Quick Stop Active	xxxx xxxx x00x 0111	The drive functions and power output are enabled, the quick stop function is being executed or finished and the motor stopped (depending from object 605Ah.0h)

State	Statusword	Description
Fault Reaction Active	xxxx xxxx x0xx 1111	The drive functions and power output are disabled; if the drive is in fault condition a system reset is necessary to re-active completely the drive functions
Fault	xxxx xxxx x0xx 1000	A fault is occurred in the device, the drive functions and power output are disabled

Table 6.1: Drive states

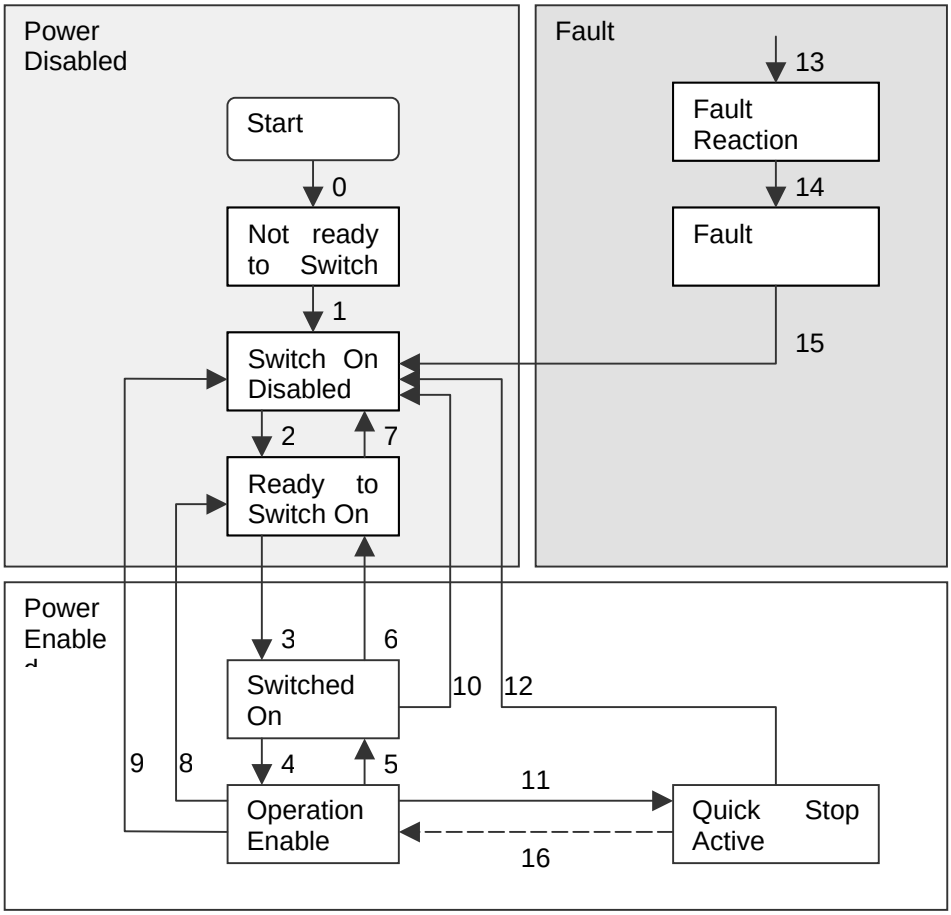


Figure 6.1: Device Control State Machine

Transition	Event	Action
0	Reset	Internal self-initialization
1	Self-initialization finished	Activate communication
2	Shutdown	None
3	Switch On	Enable power output
4	Enable Operation	The drive functions are enabled and torque could be applied
5	Disable Operation	Drive functions disabled; the motor shaft is brake with the actual ramps values
6	Shutdown	Disable power output
7	Quick Stop o Disable Voltage	None
8	Shutdown	Drive functions and power uotput disabled; motor shaft free

9	Disable Voltage	Drive functions and power uotput disabled; motor shaft free
10	Disable Voltage or Quick Stop	Drive functions and power uotput disabled; motor shaft free
11	Quick Stop	The quick stop function is executed, (see object 605Ah.0h)
12	Quick Stop executed or Disable Voltage	Drive functions and power uotput disabled; motor shaft free
13	Drive ***Fault***	Drive functions and power uotput disabled; motor shaft free
14	Fault reaction completed	Drive functions and power uotput disabled; motor shaft free
15	*Fault reset*	Reset of the fault condition; ***a system reset is necessary to make again the drive in the "Switch On Disabled" state.*** The bit Fault Reset in the command word has to be cleared by the host
16	Enable Operation	The drive functions are enabled; the transition is possible according to the object 605Ah.0h

Tabella 6.2: State transition

The drive functions depend from the selected mode of operation (object 6060h.0h), that could be checked reading the mode of operation display (object 6061h.0h); this selection also modifies the behaviour of some bits of the controlword and the statusword. The specific drive function is executed only when the drive status is **Operation Enabled**.

6.2.1 DSP 402 object

Object	Type	Attributes
6040h.0h → Controlword	Unsigned16	RW
6041h.0h → Statusword	Unsigned16	RO
605Ah.0h → Quick stop option code	Integer16	RW
6060h.0h → Mode of operation	Integer8	WO
6061h.0h → Mode of operation display	Integer8	RO
6085h.0h → Quick stop deceleration	Unsigned32	RW
603Fh.0h → Error code	Unsigned16	RO

Tabella 6.3: Device Control related objects

6040h.0h: controlword

The controlword contains the bits for controlling the state machine and for controlling the specific operating mode.

15 11	10 9	8	7	6 5 4	3	2	1	0
Manufacturer specific	Reserved	Halt	Fault reset	Operation mode specific	Enable operation	Quick stop	Enable voltage	Switch on
O	O	O	M	O	M	M	M	M

Tabella 6.4: Structure of controlword

O → Optional M → Mandatory

NOTE: the bit number 7 "Fault reset" execute an hardware reset of the drive.

Command	Controlword	Transitions
Shutdown	xxxx xxxx xxxx x110	2,6,8
Switch On	xxxx xxxx xxxx x111	3
Disable Voltage	xxxx xxxx xxxx xx0x	7,9,10,12
Quick Stop	xxxx xxxx xxxx x01x	7,10,11
Disable Operation	xxxx xxxx xxxx 0111	5
Enable Operation	xxxx xxxx xxxx 1111	4,16
Fault Reset	xxxx xxxx 1xxx xxxx	15

Table 6.5: Commands in the controlword

The bits from 4 to 6 are operating mode specific bits:

Modalità	6	5	4
Profile position mode	abs / rel	---	New set-point
Profile velocity mode	Reserved	Reserved	Reserved
Torque mode	Reserved	Reserved	Reserved

Table 6.6: Operation mode specific bits

The reserved bit are for future enhancements, should be kept to 0.

6041h.0h: statusword

The statusword indicates the current state of the drive and the current state of the specific operating mode.

Bit	Name	Description
0	Ready to switch on	M
1	Switced on	M
2	Operation enabled	M
3	Fault	M
4	Voltage enabled	M
5	Quick stop	M
6	Switc on disabled	M
7	Warning	O
8	Manufacturer specific	O
9	Remote	M
10	Targhet reached	M
11	Internal limit active	M
12-13	Operation mode specific	O
14-15	Manufacturer specific	O

Table 6.7: Structure of the statusword

The operation mode specific bit are not implemented.

6060h.0h: mode_of_operation

This parameter switches the operation mode. The possible values are:

Value	Description
1	Profile position mode
3	Profile velocity mode
128	Torque mode

Table 6.8: Possible mode of operations

A read of **modes of operation** shows only the value of the parameter. The present mode of the drive is reflected in the object **modes of operation display** (object 6061h.0h).

6061h.0h: mode_of_operation_displayed

The modes of operation display shows the current mode of operation. The meaning of the returned value corresponds to that of the modes of operation option code (object 6060h.0h).

605Ah.0h: quick_stop_option_code

This determines what action should be taken if the **Quick stop** function is executed (transition 11). The action could be one of the following:

Option code	Description
0	Disable drive function
5	Slow down with current ramps (variables sysRg250_CwDec and sysRg250_CcwDec, see Chapter 11.2 appendix 2) and stay in quick stop
6	Slow down with quick stop ramp (object 6085h.0h) and stay in quick stop.

Table 6.9: Quick stop option codes

If 5 or 6 is selected the drive will stay on “stop” state since the controlword bit 2 is set.
The default value is 5.

6085h.0h: Quick stop deceleration

The quick stop deceleration is the deceleration used to stop the motor if the quick stop ramp is selected as option code (number 6).

603Fh.0h: error code

Displays the last alarm detected from the drive, following the standard “error code”. See Chapter 11.1 Appendix 1 for alarm codes and descriptions.

6.3 Profile Velocity Mode

A target velocity (object 60FFh.0h) is applied to the trajectory generator; it generates a velocity demand value (object 606Bh.0h) that is feed as reference speed to the internal speed loop. These two function blocks are controlled by individual parameter set.

The trajectory generator support only linear ramp (trapezoidal profile), with separate parameters for acceleration (object 6083h.0h) and deceleration (object 6084h.0h).

This mode is driven by specific bits of the statusword, as follow:

State	Statusword	Description
Target Reached	xxxx x1xx xxxx xxxx	The target velocity is reached or, if an halt command is issued, the velocity of the motor is zero

Table 6.10: Managed “operation mode specific” bit in the statusword

The “Halt” bit of the controlword is not managed by AxM.

6.3.1 Profile Velocity objects

Indice	Nome	Tipo	Attr
6069h	velocity_sensor_actual_value	Integer32	RO
606Ah	sensor_selection_code	Integer16	RW
606Bh	velocity_demand_value	Integer32	RO
606Ch	velocity_actual_value	Integer32	RO
60FFh	target velocity	Integer32	RW
oggetti comuni anche alla modalità **Profile Position mode**			
6064h	position_actual_value	Integer32	RO
607Fh	max_profile_velocity	Unsigned32	RW
6083h	profile_acceleration	Unsigned32	RW
6084h	profile_deceleration	Unsigned32	RW
6086h	motion_profile_type	Integer16	RW

Tabella 6.11: Profile Velocity objects and P. Velocity/ P. Position shared objects

6069h.0h: velocity_sensor_actual_value

The velocity sensor present value describes the velocity read from the encoder in d.u. (see variable SYS_ENC1_VI_PO, menù Encoders ↳ Monitor ↳ Primary 4.2.3).

606Ah.0h: sensor_selection_code

The source of the “velocity sensor actual value” can be determined using this parameter. Actually, on the AxM drives, only the position value coming from the encoder is evaluated, so only 0 is admitted.

606Bh.0h: velocity_demand_value

Is the output value of the trajectory generator; it is equal to the variable sysRg250_LinOut, see chapter 11.2 Appendix 2.

606Ch.0h: velocity_actual_value

This object represents the present value of the velocity measurement device and it has the same means of the 0bject 6069h.

60FFh.0h: target velocity

The target velocity is the input for the trajectory generator (variabile *sysRg250_SpdRef* Chapter 11.2 Appendix 2).

6064h.0h: position_actual_value

This object represents the present value of the position measurement device, (variabile *sysSpl250_PosGiri* Chapter 11.2 Appendix 2).

607Fh: max_profile_velocity

Is the maximum allowed speed in either direction during a profiled move (variables *sysRg250_PosspLim* and *sysRg250_NegspLim* Chapter 11.2 Appendix 2). Set the clockwise limit at sub-index 0 and the counter-clockwise limit at sub-index 1.

6083h: profile_acceleration

This object is the acceleration value (variables *sysRg250_CwAcc* and *sysRg250_CcwAcc* Chapter 11.2 Appendix 2). Set the clockwise acceleration at the sub-index 0 and the counter-clockwise acceleration at the sub-index 1.

6084h: profile_deceleration

This object is the deceleration value (variables *sysRg250_CwDec* and *sysRg250_CcwDec* Chapter 11.2 Appendix 2). Set the clockwise deceleration at the sub-index 0 and the counter-clockwise deceleration at the sub-index 1.

6086h.0h: motion_profile_type

The motion control type is used to select the type of motion profile used to perform a profiled move. The AxM drive perform only linear trajectory (default value is 0).

6.4 Profile Position Mode

A target position (object 607Ah.0h) is applied to the trajectory generator and after this is feed as reference position to the internal speed loop.

The trajectory generator support only linear ramp (trapezoidal profile), with separate parameters for acceleration (object 6083h.0h) and deceleration (object 6084h.0h) and velocity profile (object 6081h.0h) .

This mode is driven by specific bits of the controlword and the statusword, as follow:

Command	Controlword	Description
New Set Point	xxxx xxxx xxx1 xxxx	Assume new “target position”
Abs / rel	xxxx xxxx x1xx xxxx	If 0 the target position is an absolute value, if 1 is a relative value (incremental)
Halt	xxxx xxx1 xxxx xxxx	Stop the motor with the profile deceleration (depend from the object 605Dh.0h)

Table 6.12: Managed “operation mode specific” bits in the statusword

State	Statusword	Description
Target Reached	xxxx x1xx xxxx xxxx	La “target position” è stata raggiunta (vedi oggetti 6067h.0h e 6068h.0h); ***non gestito nel caso di “halt” attivo***.
Set point acknowledge	xxx1 xxxx xxxx xxxx	Il generatore di profili ha assunto lal nuova “target position”
Following Error	xx1x xxxx xxxx xxxx	Errore di inseguimento

Table 6.13: Managed “operation mode specific” bits in the controlword

6.4.1 Oggetti del Profile Position mode

Index	Name	Type	Attr.
6067h	Position window	Unsigned32	RW
6068h	Position window time	Unsigned16	RW
607Ah	target_position	Integer32	RW
6081h	profile_velocity	Unsigned32	RW

Table 6.14: Profile Position objects

See also table 6.11 for the object shared with the “profile velocity mode” (paragraph 6.3.1).

6067h.0h: Position window

The position window defines a symmetrical range of accepted positions relatively to the target position:

$$(target\ position - position\ window; target\ position + position\ window)$$

If the present value of the position encoder is within the position window, this target position is regarded as reached. One encoder turn is equal to 65536 counts. Set (2^32) – 1 to disable the Position window control.

6068h.0h: Position window time

When the present position is within the position window during the defined position window time, the corresponding bit 10 target reached in the statusword will be set to one. Expressed on ms.

607Ah.0h: target_position

The target position is the position that the drive should move to in position profile mode (variable *sysPg_QTarget,* Chapter 11.2 Appendix 2) using the current settings of motion control parameters such as velocity, acceleration, deceleration, motion profile type etc.

6081h.0h: profile_velocity

The profile velocity is the velocity normally attained at the end of the acceleration ramp during a profiled move and is valid for both directions of motion. This object is re-mapped on object “max_profile_velocity” (607Fh.0h) on sub-index 0.

6.5 Torque Mode

This profile is not the standard “Profile torque mode” but a proprietary profile where a target torque (object 6071h.0h) is fed to the input of the current loop and generates instantaneously the desired torque on the motor shaft.

No additional controlword or statusword bits are used in this mode.

Index	Name	Type	Attr.
6071h	target_torque	Integer16	RW
6073h	max_current	Unsigned16	RW

6071h.0h: target_torque

This parameter is the input value for the current loop in Torque mode (variable *sysSpl250_CicIsqRef* Chapter 11.2 Appendix 2). The torque value is given by this parameter multiplied by the motor torque constant (Kt): *Torque = Current x Kt*

6073h.0h: max_current

This is the maximu value for the current reference (variable *sysSpl250_IMax* Chapter 11.2 Appendix 2).

7 PHASE STANDARD APPLICATIONS

The base applications supplied by Phase Motion Control for the AXM for motion control of brushless motors are designed for classic drive applications. Such software change the AXM in a versatile digital drive, operating in current or speed loop and grant a very high freedom in the use of inputs and outputs Analog-digital making possible the implementation of additional features not included in the "default" drive operation. The applications presently available are briefly outlined in the following.

7.1 SpeedV

SPEED-V is a base application mainly aiming to control motor speed or current.
Speed control means the motor speed must follow as much as possible accurately a requested value, generally told reference: the reference pursuit must be accomplished not only in static conditions but in dynamic conditions too, during the quick changes in the reference itself
Current control means to impose a prefixed value of the current in the motor windings so that it can transform in torque allowing the motor to accelerate or decelerate.

The main Speed-V characteristics are:

- Full digital control of direct and quadrature current, updated at 4 kHz frequency.
- Digital and Analog encoder support.
- Multiple parameterization: 8 different parameterizations (task) can be memorized for the same system. The different parameterizations can be recalled through the 3 digital inputs settings also when the drive is operating.
- The task parameters allow to configure:
  - Current/Speed operating mode selection.
  - Selection of the reference from parameter or from Analog input.
  - Current limit.
  - Linear ramps with set speeds, accelerations and decelerations or speed steps.
  - Speed loop gains.
  - Reference scale on standard interface Analog differential +/- 10 V.
- Encoder simulation: this function allows to simulate a step motor operation with the simulated encoder resolution programmed by the application itself.
- Electric shaft: this pursuit function asks the drive to set its speed reference as a function of the speed of a master shaft, whose encoder is connected to the "auxiliary encoder" port. It allows to avoid all generic mechanical gear couplings. The speed ratio between master and slave shaft is configurable.

In the following table are the inputs description:

Input	Name	Functions	Descriptions
Digital 0	DI0	Drive enable	The drive is enabled on the rise edge of this input.
Digital 1	DI1	Zero reference	If it is set the referneces (speed and current) are put to zero.
Digital 2	DI2	Polarity inversion	If it is set the polarity of the referneces are changed.
Digital 3	DI3	Clockwise end run	If active all speed reference higer than 0 is atomatically reset to 0.
Digital 4	DI4	Counter-clockwise end run	If active all speed reference lower than 0 is atomatically reset to 0.
Digital 5	DI5	Selector task, bit 0	Through a binary sequence of this inputs it is possible to select the desired task: DI5,DI6,DI7 → task 000 → 0 001 → 1 010 → 2
Digital 6	DI6	Selector task, bit 1	

Digital 7	DI7	Selector task, bit 2	011 → 3 100 → 4 101 → 5 110 → 6 111 → 7
Analog 0	AI0	Speed reference	If the drive is on speed control (selectable by T*x*_SP_LOOP parameter) this analog input changes the speed reference.
Analog 1	AI1	Current refence / Current limit (*)	If the drive is on current (torque) control (selectable by T*x*_SP_LOOP parameter) this analog input changes the current reference.

Table 7.1: Digital and analog input use in speedV application

(*) When the speed loop is selected and the task parameter Tx_AN_CURLIM is set, the analog input 1 (AI1) change directly the current limit of the drive (with 10V at this input the minimum between Tx_I_LIM and SYS_MOT_IDM is used, like without the dinamic limit enabled).

The drive activate the following digital output:

Output	Name	Function	Description
Digital 0	DO0	Enabled	This output is enabled when the drive is ON and no allarms are present.
Digital 1	DO1	Speed Ok	The drive activates the set speed reference.
Digital 2	DO2	Speed zero	Motor speed zero
Digital 3	DO3	Drive Ok	This output is enabled when no allarms are present.
Digital 4	*DO4*	*Current limit*	*The drive is supplying the limit value of the current.*
Digital 5	*DO5*	*End-run*	*End-run active.*
Digital 6	*DO6*	*Transient*	*The drive is executing an acceleration or deceleration ramp.*
Digital 7	*DO7*	*Index*	*This output is enable for 8ms at every encoder index crossing.*

Table 7.2: Digital output used in the speedV application

NOTA: The output number 4, 5, 6, 7 are not phisically output but are only simulate by the “Control Panel” software interface.

7.2 Positioner

POSITIONER is an application allowing to use the AXM drive as multi-position programmable positioner. The Positioner main features are:

- Possible use of 32 positions selectable by digital inputs. Every position is configurable. Position expressed in the unit chosen by the user.
- Selection between absolute or incremental displacement.
- Speed, acceleration and deceleration to be used during the displacement.
- Space and time units definition at user choice.
- Zero cycle practicable by zero sensor and encoder pulse to get the max. precision and repeatability of the cycle itself.
- Jog commands.
- End of stroke inputs.

- Analog input with feed-rate function.
- Analog outputs and monitor variables for actual speed, position error, requested current, etc.

In the following table are the inputs description:

Input	Name	Function	Description
Digital 0	DI0	Enable	The drive is enabled on the rise edge of this input.
Digital 1	DI1	Start	Enable the homing procedure and (when the zero position is found) start the new positioning.
Digital 2	DI2	Homing sensor	Connect here the limit swith for the homing procedure.
Digital 3	DI3	Jog **-** / Clockwise end-run / Position bit n°3	*SEL_DI_3_4* parameter (menù "I/O Configuration" IPA 15000) select the function of this inputs: Quote / Jog / Hw_limits
Digital 4	DI4	Jog **+** / Counter clockwise end-run / Position bit n°4	
Digital 5	DI5	Position bit n°0	This inputs, plus DI3 e DI4, define the number of the target position: DI3,DI4 DI5,DI6,DI7 → Target position 00 000 → Quote 0 00 001 → Quote 1 00 010 → Quota 2 … 00 111 → Quota 7 01 000 → Quota 8 … 11 111 → Quota 32
Digital 6	DI6	Position bit n°1	
Digital 7	DI7	Position bit n°2	
Analog 0	AI0	FEEDRATE	If the parameter *ENFEEDRATE* (IPA 15006) is set to "*Analog*" the input voltage applied to AI0 percentage reduce the value of positioning speed and acceleration.

Table 7.3: Digital and analog input use in positioneer application

The drive activate the following digital output:

Output	Name	Function	Description
Digital 0	DO0	Enable	This output is enabled when the drive is ON and no allarms are present.
Digital 1	DO1	Zero Ok	This output is enabled when the drive has executed correctly the homing procedure.
Digital 2	DO2	Position Ok	Target position reached.
Digital 3	DO3	Position error	Position error.

Table 7.4: Digital output used in the positioneer application

7.3 Basic

Basic is a base application aiming to the user introduction to dedicated applications development. The main Basic features are:

- Digital and Analog encoder support.
- Drive enabling and control selection by digital inputs.

- Reference on standard interface Analog differential +/- 10 V.
- Parameterization allowed during operation too.
- Separated linear ramps for accelerations and decelerations, CW e CCW.
- Speed digital loop gains with zero actual speed, PII2D controller.

In the following table are the inputs description:

Input	Name	Function	Description
Digital 0	DI0	Enable drive	The drive is enabled on the rise edge of this input.
Digital 6	DI6	Control selector	If this input is high the speed control is selected; if not the current control is selected.
Analog 0	AI0	Speed reference	If the drive is on speed control (selectable by T*x*_SP_LOOP parameter) this analog input changes the speed reference.
Analog 1	AI1	Current reference	If the drive is on current (torque) control (selectable by T*x*_SP_LOOP parameter) this analog input changes the current reference.

Tabella 7.5: Digital and analog input use in basic application

No digital output are managed by this application.

7.4 Load and execute a base application

The configuration tool installation setup, install on the PC the standard application set. It's very easy to load on the drive a specific application.
To do it, go back to the opening page with the command "Application Manager" of the menu "File" (or with the key of the instruments bar).. Double click on the application to be downloaded. The configuration tool will create a copy of the application in the directory and with the name specified by the user. This operation allows to work on the local copy, preserving the integrity of the original application installed by setup. The new application created includes all source code in PLC language and, if necessary , can be modified and personalized by the user by means of the GPLC (see chapter 8).
This directory includes:

HTML: directory containing the html pages of the application configuration.
SOURCE: directory containing the application source code (if necessary the code can be modified using the GPLC program)..
NameApp.par: Cockpit table for the application configuration.

The application compilation and loading on the drive, occur automatically at the moment when its copy is created in the user directory. When the loading is ended, the table related to the parameters configuration will be opened automatically. Assign the desired values to the parameters, write them on the drive (Write all) e save them in flash (Save). Save on disk the table with the set values (Menu "*File*", command "*Save*") (refer to the par. 3.3.2).
Later on, to have access to the application parameters, the only action to do will be to open the related table. It's not necessary to create every time a new table.
To enable any application be sure that the system parameter SYS_SEL_MODE is set to "Plc", loading the system parameters table (file sys_AxM_02.par) from the work directory with the command "*Open*" of the menu "*File*" and, in case, modifying and saving SYS_SEL_MODE.

To download the same application into another drive o to download a new application is possible to select "Rebuild application", menù "Application" from the application parameter table. If the Source directory, with all the PLC project files, is correctly at the same path af the table, Cockpit tool will compiling and downloading automaticly the application.

8 USER APPLICATIONS

This chapter shows the user how to make use of the software development ambient GPLC in order to create dedicated applications to be carried out by the AXM drives family.

8.1 The GPLC development ambient

Following comes the description of properties and performances of the GPLC compiler aiming to carry out new applications. Pls. refer to the related manual for a more detailed and exhaustive description.
GPLC is an application program to be used on personal computers provided with Microsoft Windows 95/98 or NT O. System.
The program main elements are:

- Integrated text editor to allow programs editing using PLC language.
- Tabular Editor for the parameters table definition.
- Source modules compiler in PLC language.
- Communication interface to download the PLC code created into the AXM drive.
- Monitor window to visualize the variables used in the PLC program.

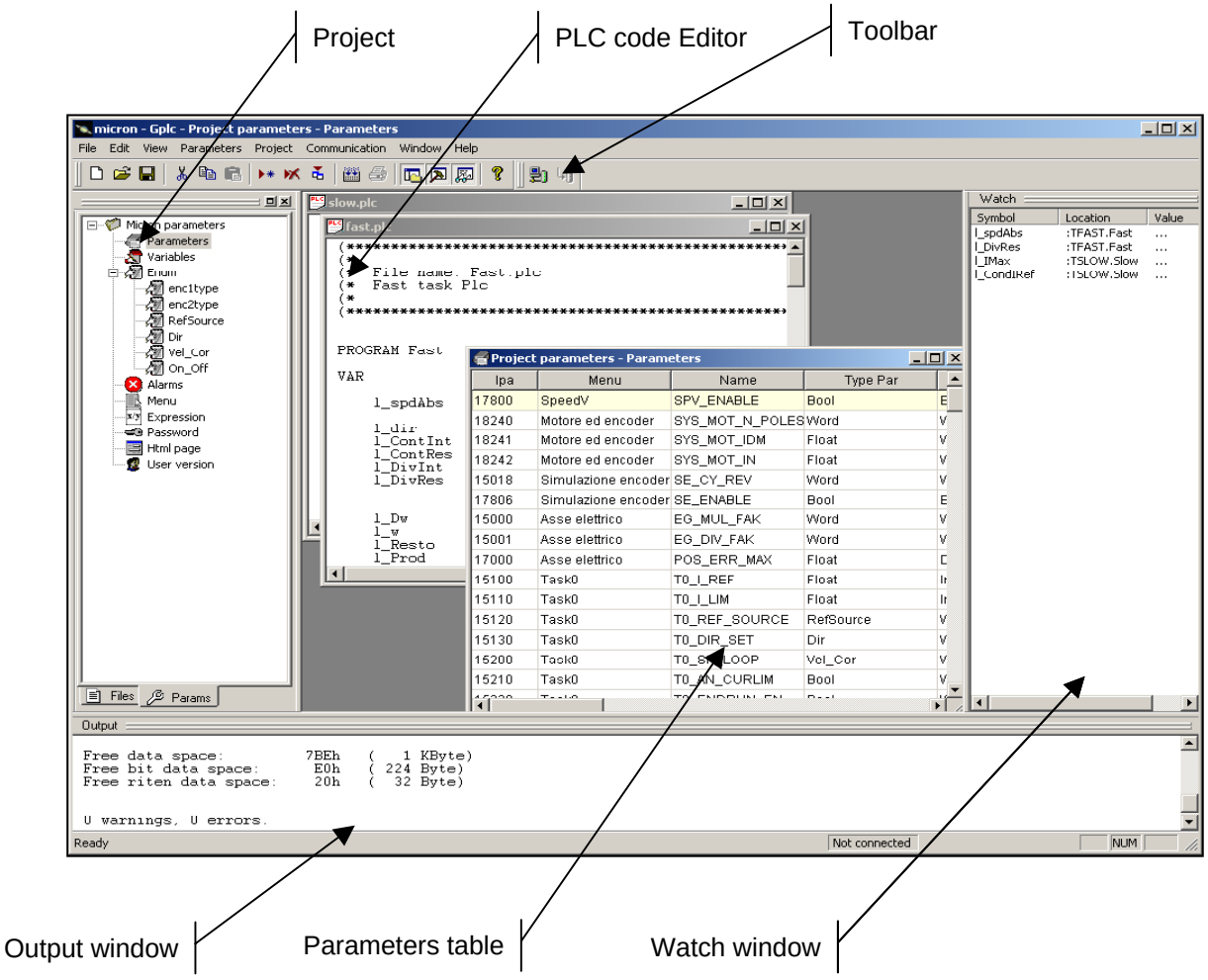


Figure 8.1: Main elements of the GPLC compiler

8.2 How to create or modify an application

The creation of a new application for the AXM platform can be activated by the option "*File – New Project*". MDPlc asks for the new project name and for the directory where to record all files of the project itself.

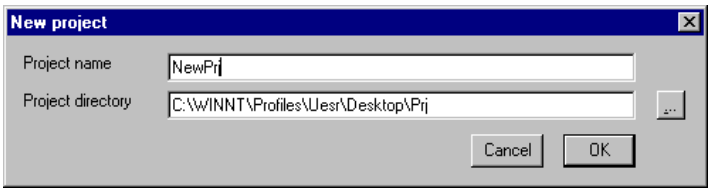


Figure 8.2: Window for setting application name and path

Further GPLC shows the dialog-box "*Project settings*" to allow the operator to set all elements required for the project configuration (se further paragraph). The dialog-box can be later recalled to modify some project elements or to add or cancel the source modules from the project.
Also is possible to open an existing project in order to modify it according to new requirements, selecting the option "*File – Open project*". This option opens the standard window for files searching.
The GPLC project files are named as the requested project with the extension ".PPJ". Never edit or modify the ".PPJ" files with other programs. As alternative you can select the project in the list of the last used files shown in the "*File*" menu.

8.3 Application components

A GPLC project includes in itself all elements (source modules, memory maps and tasks definition) requested for the generation of a machine code file (file .COD) to be further sent to and executed by the AXM drive.
The components of an application developed with GPLC are following:

- one or more source modules PLC IEC1131-3;
- one file with .IMG extension, including the drive memory map, where the generated code must be sent;
- the tables for the definition of parameters used by the application;
- the association between the programs coded in the source modules and the AXM drive executive tasks.

All information requested for a GPLC project formulation, are memorized in files carrying the .PPJ extension.
The set of all told elements is processed, at project level, by a special dialog-box invoked with the menu option *"Project – Settings*": Such dialog-box can be always recalled in order to modify some project elements.

8.3.1 Source modules

The source modules are made up of standard ASCII files with extension (non mandatory) .PLC.
To edit the source modules text, every ASCII editor can be used: it is not required to use the GPLC integrate editor.
The source modules list can be set by the suitable dialog-box *"Project – Settings"*. A GPLC project can be made up by a whatever number of source modules.

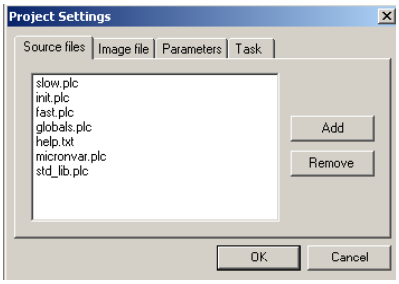


Figure 8.3: Project source modules

The integrated editor allows to modify the open source modules with the command *"File – Open"*, and it is also endowed with the more common functions of the Windows, particularly:

- Text selection.
- Cut, copy and paste operations.
- Search and substitution.
- Drag-drop of text selections.
- Text selections dragging.

All these options are available in the *"Edit"* submenu. This is enabled when at least one text file is opened. Furthermore the editor includes the following functions:

- Visualization of the line and column number in the status bar.
- Automatic positioning corresponding to compiling errors.

The positioning on the text block including compiling errors, occurs when the mouse left key is double-clicked on the error line shown in the *"output window"* (see fig. 8.1).

8.3.2 IMG file

The IMG files include description and values of the memory map of the drive to whom the machine code generated by the compiler is devoted. An IMG file is associated in biunique mode with a drive firmware version. In other words, for every firmware version only one IMG file does exist and vice versa. The connection between an IMG file and a firmware version is determined by a 32 bit code present in both.
The content of the IMG file is in ASCII format but its content must absolutely not be modified with some editor or such.
Normally, in the PLC projects directory are present the IMG files associated with the existing AXM drive firmware versions.
If any IMG file should'nt be allowable, this can be anyhow obtained with an upload operation from the AXM drive (menu *"Communication - Upload IMG file"*).
The machine code generated by the PLC compiler includes also the identification code of the IMG file used for the compilation. In this way the target board can reckon if the received code is compatible with it's own firmware; if not the PLC execution is not enabled.
Every attempt to send some code to a drive with a different memory image, is aborted by the compiler. In this case you must upload the IMG file and re-compile the project.
The IMG file used for the project must be indicated in the suitable dialog-box *"Project - Settings"*.

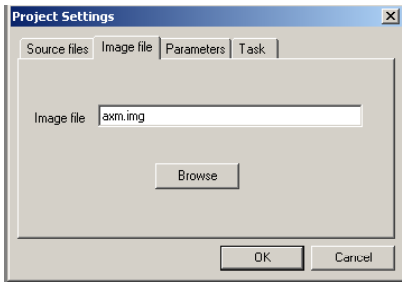


Figure 8.4: IMG file setting

8.3.3 Parameters table

The parameters are in every respect variables used internally by the PLC program. Unlike of the conventional variables, the parameters can be modified and/or read by the "Cockpit" configurator.
The parameters function is that of allowing the configuration and supervision of the application through the communication interface with the AXM drive.

During the project elements setting, it's necessary to indicate the name of the parameters file (to be used later with the "Cockpit" configurator) that GPLC must generate in the course of the compilation of the project itself, and the file with the variables associated with each parameter.

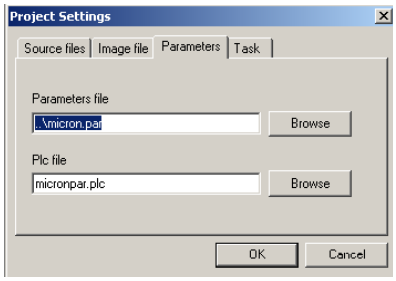


Figure 8.5: Parameters setting

8.3.4 Application task

The AXM drive firmware system is made up of tasks executed in cyclic sequence with a preset period. The user applications too are structured this way: it becomes necessary to define executive task to be performed in synchrony with the correlated firmware tasks.
The application tasks have the following properties:

Name	Period
Init	8 ms
Bgnd	--
Slow	8 ms
Medium	2 ms
Fast	250 µs

Figure 8.6: Task timing

As shown in the table, every task has a preset execution period. This means that, e.g. the task Slow begins its cycle every 8 milliseconds.
Every task must terminate its execution before the end of its cycle time. In case a task lasts longer than the period assigned to it, the system automatically disables the performance of the executive tasks and goes in alarm condition.
The task **Init** is activated at every system start (at the start up or after a reset) and it is executed until the program enables one or both the tasks **Slow** and **Fast** (see GPLC manual).
If the application task **Init** is not defined, the tasks **Slow** and **Fast** become automatically activated after the drive reset. For the definition of the application executive tasks, GPLC provides the dialog-box *"Project - Settings"* . It is not necessary that an application defines all the tasks. It is possible to build up projects operating with one task only, chosen among the available.

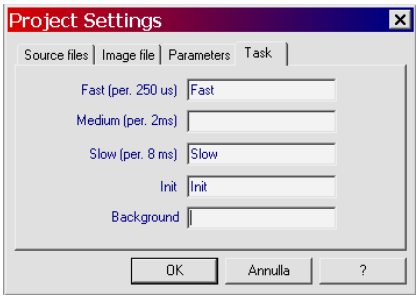


Fig. 8.7: Application task setting

In fig. 8.7 for example, 3 source modules named Fast.plc, Slow.plc, Init.plc, will be created. Their code will be executed with a period defined by the previous table.

The tasks Background e Medium must be defined even if they are not used by the application; in this case they must generate two empty files.

8.4 Interaction with firmware

A GPLC project includes in itself all elements (source modules, memory maps and tasks definition) requested for the generation of a machine code file (file .COD) to be further sent to and executed by the AxM drive
However the application must interact with the firmware system on board of the drive so that it can read and/or set variables not belonging to the application, but defined as “system variables” because they can modify drive regulation, control and condition.
In this paragraph will be specified the types of variables available to the user permitting to interface the dedicated application with the AxM system.

8.4.1 Application parameters

The application parameters are user defined parameters that can be transferred and modified during the dedicated application operation using the AxM drive communication interface ("Cockpit").
The AxM firmware provides 8 memory zones (data block) for the application parameters definition, different by type (16bit, 32bit, float, bit), and/or write/read properties (R/W). Every time the user defines a new parameter, implicitly allocates a variable in the drive firmware (associated variable) in the memory zone devoted to the declared parameter type.
The following table resumes the application parameters data block.

Data block	Parameter type	Number of parameters	IPA	Properties
10	16-bit parameters	512	15000 – 15511	R/W
11	32-bit parameters	512	17000 – 17511	R/W
12	bit parameters	128	17800 – 17927	R/W
13	float parameters	512	16000 – 16511	R/W
20	16-bit parameters	512	9000 - 9511	R
21	32-bit parameters	512	13000 – 13511	R
22	bit parameters	128	17600 – 17727	R
23	float parameters	512	11000 – 11511	R

Figura 8.8: Application parameters data block

Every parameter is actually made up with many fields whose value can be modified using the parameters table editor. The fields are thereafter briefly described.:

Ipa:
Is the parameter index, or the number used to identify the parameter in univocal mode during the communication with the drive. The parameter indexes are automatically generated by the parameter tables editor every time a new parameter is input, correlated with the type of datum assigned to the parameter. The valid intervals for the parameter indexes are shown in the previous table.

Menu:
Means the “logic” group to whom the selected parameter belongs. Typically the parameters are grouped in functionally homogeneous sets. The belonging menu of each parameter can be selected among the menus currently defined in the proper table.

The splitting in menus is used for the parameters presentation in the "Cockpit" configurator.

Name:
Represents the symbolic and univocal name to identify the parameter. As told before GPLC automatically generates for each parameter a firmware associated variable, accessible in the application placing the letter 'p' before the parameter name both in writing/reading or 'v' for parameter only for reading (e.g. to the parameter CURR corresponds the associated variable pCURR).

TypePar:
Represents the datum type (integer, floating point, boolean etc.) of the parameter exchanged using the communication interface.

TypeTarg:
Is the datum type of the variable associated to the parameter. The parameter and the associated variable can have both the datum type and the value different between themselves.
The parameter conversion into associated variable and vice versa is carried out by the parameters database. This feature allows to process the parameters with datum types and suitable units of measure (engineering units) and to get correspondent associated variables suitably converted in internal units.

Value:
Represents the default value assigned to the parameter and transferred into the parameters file used by the "Cockpit" configurator.

Min and Max:
They define, if specified, the minimum and maximum limits to be assigned to a parameter.
In order to disable the control of one of these limits, assign the conventional value '*' in the related field.

Scale and Offs:
They define, optionally, the multiplicative and additive factors used to numerically convert the parameter in the associated variable.

Unit:
Is the descriptive string of the unit of measure.

Description:
Contains a brief description of the parameter.

Note:
Shows extended notes and descriptions associated to the parameter.

Format:
Defines the parameter visualization format. The format description rules as defined by the ANSI C standard for the *printf()* function must be used.

All the application parameters are grouped in a database, split in two sections (*Parameters* for application parameters of writing/reading and *Variables* for those of reading only) and accessible by the *"Project window".* The parameter tables editor allows to insert or process the different record types.
To insert a new application parameter, open the related parameter table (*Parameters* or *Variables*) from the *"Project window"* and make use of the menu option *"Parameters – Insert"* or the related toolbar key :
it will appear the la dialog-box *"Parameters types"* to require the parameter type to be inserted.

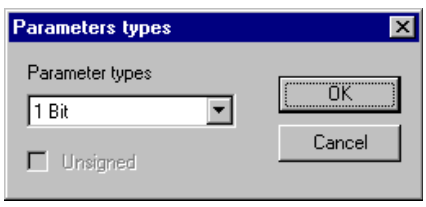


Figure 8.9: Type parameter selection

This dialog-box has the purpose of automatically generate the right parameter index as a function of the chosen type.
To remove a record from the parameter tables, use the option of the menu *"Parameters – Delete",* or the related toolbar key .
The alteration of individual table fields is carried out positioning the mouse and clicking over a desired cell. Depending from the selected field, the alteration can occur by direct text modification or by selection among a set of predefined values.

8.4.2 Internal variables

These are the declared variables inside the application: they are not properly related to the system firmware on board of the drive, but they allow to perform operations, computations, controls inside the source modules. They can be "local" for every single module or "global" for the whole application.

8.4.3 System variables

The system variables are the variables used by the AxM drive firmware for regulation and control.
The GPLC compiler is supplied by Phase Motion Control and includes files showing the declaration of all system variables of the AxM drive, to those the user can access for his dedicated application.
These files have name like **AxmVars*X*.plc** where *X* means the related drive firmware version number.
The files **AxmVars*X*.plc** must be included in every project and must be taken out of the directory of the GPLC library, installed in the PC. If the new projects creation function is used (see paragraph 8.2) these files are automatically copied by GPLC into the directory selected for the new user application. Files with system variables in no way must be modified by the user, in order to avoid all misfunction of the generated application program.

8.4.4 Process imaging

It must be observed that in most part of the system variables, the compiler generates a process image of the variables themselves. This means that the application task making use of the imaged system variable, it does'nt operate directly on the firmware, but on a copy of it. Only when the performance terminates, the copy is automatically transferred on the system variable.
In the file **AxmVars*X*.plc** are supplied also imageless system variables: such variables are marked by the words '250' postponed to the functional group sign to whom they belong (e.g. sysRg250_SpdRef is the imageless speed reference belonging to the system block "Ramp generator"). The user working on such variable must consider that its modification should be "time consistent" with the task firmware where the Ramp Generator is implemented.
In Chapter 11.2 Appendix 2 is shown a detailed description of the system variables allowable in the application level together with their use explanation.

8.5 Application execution

In the following paragraphs will be explained the operations to be carried out in order to create the application machine code and execute it on the AxM drive.

8.5.1 Compilation

- The project is compiled by the option "*Project – Compile project*" or by the suitable toolbar key . During the compilation process, in the "*Output window*" the individual phases of the process are visualized together with the error and warning list as issued by the compiler during the execution.
- If the compilation did not produce errors, the compiler generates a file .COD containing the machine code for the AxM drive.

- The *"Output window"* shows then the data related to the code and PLC program data dimensions and the parameters database dimension.
- As the compilation is ended, the compiler generates also a listed file (.LST) where all information related to the generated code are reported (assembler instructions, variables allocation, memory map etc.). This last file is generated for diagnostic purposes only.
- If compilation errors are present, the "*Output window*" shows the list of them specifying for each error the location, the code and a brief description.
- Clicking twice with the mouse on the "*Output window*" lines reporting the errors, GPLC automatically sends the cursor on the text block that generated the error.
- In presence of compilation errors, no executable code is generated and it becomes impossible any further download.
- During the compilation, GPLC can also produce warning messages. The warning messages show the presence of operations potentially problems generating during the program execution. The warning messages do not compromise the executable code generation.
-

8.5.2 Connection and drive code forwarding

As the compilation phase is ended, it becomes possible to forward the generated code to the drive.
To enable the connection with the drive select the option "*Communication – Connect*" or click on the related toolbar key. .
The communication with the drive is carried out through multi-drop serial line RS232. The standard protocol is Modbus.
Be sure to have properly set the communication interface parameters. To correctly configure the communication, make use of the option "*Communication – Settings*". To carry out a correct communication, the settings of the related dialog-box must be correspondent to those of the drive to whom the communication is aimed (see par. 3.3.1)

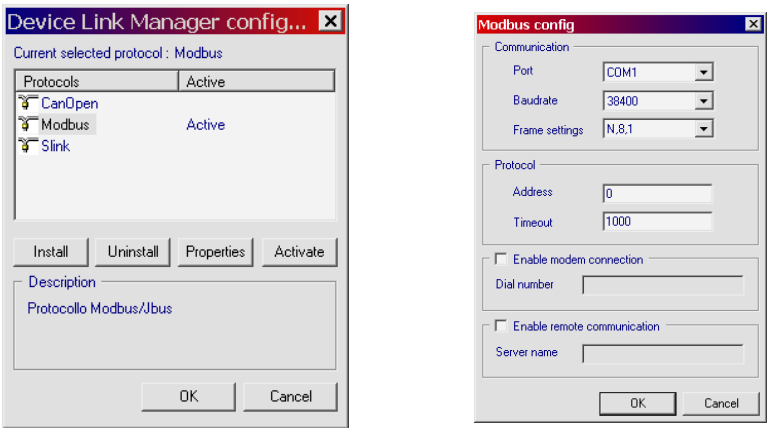


Figure 8.10: Communication parameters setting

The condition of activated connection is reported in the status bar. Moreover the menu voice "*Communication - Connect*" and the related toolbar key are activated.
Use "*Communication - Download code*" to carry out the code download.
The download execution condition is reported in the "*Output window*".
The code download produces an error if the target board is not compatible with the IMG project file.
In this case it is required to carry out the upload of the IMG file from the drive using the option "*Communication – Upload IMG file*". This operation writes the memory map data into the IMG file currently selected.

When the code download in ended, the drive is automatically reset and the new application can be executed.

8.5.3 Application diagnostic

The user application debug is feasible using the "*Watch window*"; in this window can be listed the names of one or more variables used in the program, in order to verify their values during the program execution.
When the connection is enabled, the current value of the listed variables is visualized and constantly updated by the communication interface.
To monitor the data perform the following operations:

- Compile the current project.
- If not already connected, use the GPLC menu option "*Communication – Connect*" to enable the communication interface.
- Carry out the code download.
- Move the mouse pointer on the first free position of the column "*Symbol*" of the "*Watch window*", click on with the left mouse button to activate the edit mode of the text box and enter the name of the desired variable, or select the name of a variable from the editor and drag it using the mouse on the "*Watch window*".
- When several variable exist with the same name, a dialog-box will appear to give the chance of selecting the desired variable.
- The names reported in the "*Watch window*" not related to used variables, show in the correspondent field *"Value"* the string "object not found".
- The names of the variables used in the project report, in the field "*Location*", the context where they are used and, in the field "*Value*", the value taken by the variable at that time.
- When the communication includes errors, the field "*Value*" reports the string "…" showing an undefined value.

It must be noted that the valid variables for the project are those declared and used by the programs only. The variables merely declared but not used, are not generated by the compiler and therefore they do not have any correspondent value.

9 DIAGNOSTIC

9.1 General description

The functional mode “diagnostic” allows to run a sequence of control test and to set the drive basic parameters without using software interfaces.

The diagnostic function is carried out by means of the command push-buttons “plus” and “minus” on the drive itself. The diagnostic is accessed pressing the “plus” push-button at least 2s long. When the mode is enabled, we can notice two operative phases:

Selection phase: allows to select the desired diagnostic test. Press the “plus” push-button to scan the list of the allowable diagnostics in rising mode, the “minus push-button ” in falling mode. Keep pressed the “minus” push-button for at least 2s long to get out of the diagnostic.

Run phase: carries out the diagnostic test selected in the previous phase. From the selection phase keep pressed the “plus” push-button at least 2s long. The selected diagnostic is accomplished. To get out and go back to the selection, keep pressed the “minus” push-button at least 2s long.

To get out from the diagnostic directly press together both the command push-buttons.

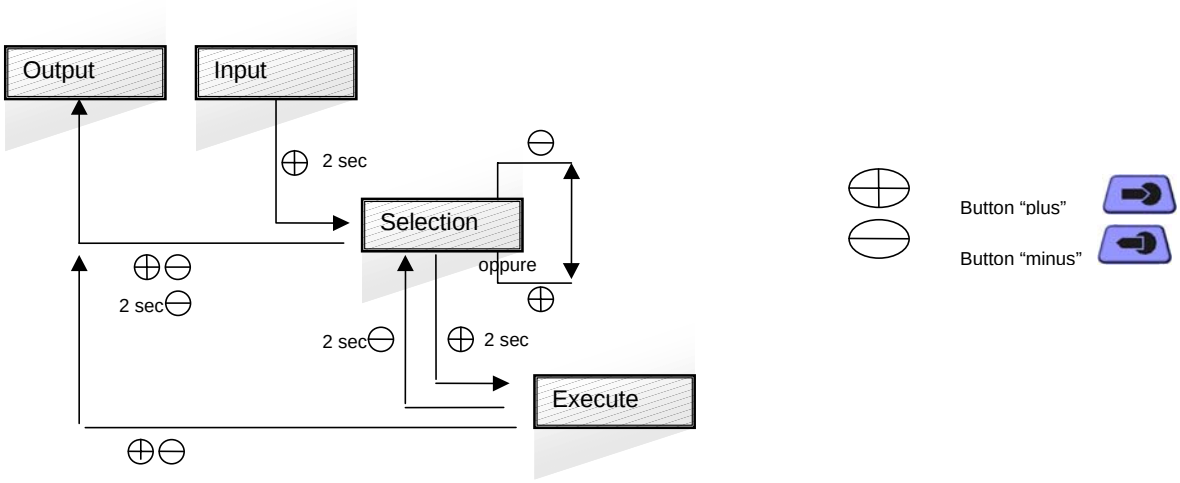


Figure 9.1: Diagnostic selection procedure

9.2 Diagnostic selection phase

The diagnostic is accessed pressing the “plus” push-button 2s long. The led 7 lights to notify the selection phase activation. By means of the “plus” and “minus” push-buttons it becomes possible to set the diagnostic to be accomplished. It’s binary code is shown by the leds 6÷0.
E.g., the selection of the Nr 2 diagnostic (Digital inputs diagnostic) will be so represented:

The diagnostics currently allowable are:

Nr	Type
1	Encoder diagnostic
2	Digital inputs diagnostic
3	Digital outputs diagnostic
4	RS-232 serial baud rate diagnostic
5	Can baud rate diagnostic
6	Analogic output 0 diagnostic
7	Analogic output 1 diagnostic
8	Analogic input 0 diagnostic
9	Analogic input 1 diagnostic
10	Dc-bus voltage diagnostic
11	Power module temperature diagnostic

To get out of the diagnostic keep pressed the “minus” push-button 2 sec. long: **changes in parameters are enabled through saving and drive reset.**

9.3 Diagnostic run phase

From the selection phase keep pressed the “plus” push-button at least 2s long. The visualization by leds depends by the type of performing diagnostic.
To go back to the selection phase, keep pressed the “minus” push-button 2s long. The visualization is same as described in the previous paragraph.

To get out from the diagnostic press together both the command push-buttons. The visualization will go back to that of normal drive run. In this case **no change in parameters will be saved**.

9.4 Diagnostic run example

Following are explained the actions needed to operate the Nr 3 diagnostic test (Digital outputs test).

Action	Led condition	Meaning
Button “plus” 2s long		Starts diagnostic in selection
Button “plus” 3 times		Selects diagnostic Nr. 3
Button “plus” 2s long		Runs digital outputs test. Digital outputs 2 and 3 enabled
Button “minus” 2s long		Ends “Digital outputs test” and starts the selection phase

Button “minus” 2s long Exit from the “diagnostic” mode

9.5 Diagnostic types

Nr 1) Encoder diagnostic: Visualizes the encoder position on the mechanical turn.

In selection phase is represented as follows:

In run phase visualizes the encoder position on the mechanical turn.
Every led visualizes a 8192 virtual counts interval (1 turn = 65535 virtual counts).

Led0 Lighted for position between 0 and 8191 virtual cnt
Led1 Lighted for position between 8192 and 16383 virtual cnt
Led2 Lighted for position between 16384 and 24575 virtual cnt
Led3 Lighted for position between 24576 and 32766 virtual cnt
Led4 Lighted for position between 32767 and 40959 virtual cnt
Led5 Lighted for position between 40960 and 49151 virtual cnt
Led6 Lighted for position between 49152 and 57343 virtual cnt
Led7 Lighted for position between 57344 and 65535 virtual cnt

E.g. For encoder position 50126 we have in return the following reading:

Nr 2) Digital inputs diagnostic: Visualizes the condition of the 8 drive digital inputs.

In selection phase is represented this way:

In run phase each led visualizes the high status (led on) or low (led off) of the related digital input, along with the following relations:

Led0 Digital input 0
Led1 Digital input 1
Led2 Digital input 2
Led3 Digital input 3
Led4 Digital input 4
Led5 Digital input 5
Led6 Digital input 6
Led7 Digital input 7

E.g. For digital inputs 2 and 5 the visualization will be as follows:

Nr 3) Digital outputs diagnostic: Visualizes the condition of the 4 drive digital outputs: allows to configure the digital outputs.

It's possible to access to the digital outputs settings in case of operation in "default" mode only (see paragraph 2.1.

In selection phase is represented this way:

In run phase the leds 0÷3 visualize the high status (led on) or low (led off) of the related digital output, along with the following relations:

Led0 Digital output 0
Led1 Digital output 1
Led2 Digital output 2
Led3 Digital output 3

It's possible to change the digital outputs condition, operating on "plus" and "minus" push-buttons and selecting a binary active outputs combination.
The change is denied if the digital outputs are simulated by "Cockpit".

The leds 4÷7 remain always off. E.g. For digital outputs inputs 2 and 3 enabled the visualization will be as follows:

Nr 4) Serial RS-232 baud rate diagnostic: Visualizes the baudrate set for the serial Rs232: allows to reset a new value.

In selection phase is represented this way:

In run phase the serial Rs-232 baudrate is visualized by lighting the related led, according to the following correlation:

Led0 > = 1200 Baud
Led1 > = 2400 Baud
Led2 > = 4800 Baud
Led3 > = 9600 Baud
Led4 > = 14400 Baud
Led5 > = 19200 Baud
Led6 > = 38400 Baud

The led 7 remains off.
It's possible to change the baudrate, acting on "plus" and "minus" push-buttons and selecting one of the previous possible values for the serial Rs232. The new setting will be active after the exit from the diagnostic and the drive reset.
E.g. For a baudrate of 14400 Baud, the visualization will be:

Nr 5) Can baudrate diagnostic: Visualizes the baudrate set for the Can communication: allows to reset a new value.

In selection phase is represented this way:

In run phase the Can communication baudrate is visualized by lighting the related led, according to the following correlation:

Led0 > = 50 Baud
Led1 > = 125 Baud
Led2 > = 250 Baud
Led3 > = 500 Baud
Led4 > = 1000 Baud

The led 5÷ 7 remain always off.
It's possible to change the baudrate, acting on "plus" and "minus" push-buttons and selecting one of the previous possible values for the Can communication. The new setting will be active after the exit from the diagnostic and the drive reset.
E.g. For a baudrate of 1000 Baud, the visualization will be:

Nr 6) Analogic output 0 diagnostic: Visualizes the analogic output 0 voltage level: allows to reset a new output value.

It's possible to access to the analogic output 0 setting in case of operation in "default" mode only (see paragraph 2.1).

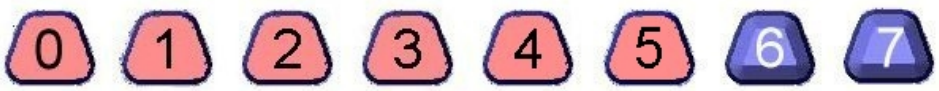
In selection phase is represented this way:

In run phase the leds visualize the analogic output 0 voltage level (0÷10V), according to the following correlation:

Led0	on if 0 analogic output level >=	1,25V
Led1	on if 0 analogic output level >=	2,50V
Led2	on if 0 analogic output level >=	3,75V
Led3	on if 0 analogic output level >=	5,00V
Led4	on if 0 analogic output level >=	6,25V
Led5	on if 0 analogic output level >=	7,50V
Led6	on if 0 analogic output level >=	8,75V
Led7	on if 0 analogic output level >=	10V

It's possible to change the 0 analogic output, acting on "plus" and "minus" push-buttons with 1,25V incremental intervals, selecting one of the previous possible values. Increments and decrements got by push-buttons are "circular", this means that the output will shift from 10V to 0V for an increment and from 0V to 10V for a decrement.
The change is forbidden if the analogic outputs are simulated by "Cockpit".

E.g. For an output voltage of 8,00V, the visualization will be as follows:



Nr 7) Analogic output 1 diagnostic: Visualizes the analogic output 1 voltage level: allows to reset a new output value.

It's possible to access to the analogic 1 output setting in case of operation in "default" mode only (see paragraph 2.1).

In selection phase is represented this way:

In run phase the leds visualize the analogic output 1 voltage level (0÷10V), according to the following correlation:

Led0	on if 1 analogic output level >=	1,25V
Led1	on if 1 analogic output level >=	2,50V
Led2	on if 1 analogic output level >=	3,75V
Led3	on if 1 analogic output level >=	5,00V
Led4	on if 1 analogic output level >=	6,25V
Led5	on if 1 analogic output level >=	7,50V
Led6	on if 1 analogic output level >=	8,75V
Led7	on if 1 analogic output level >=	10V

It's possible to change the 1 analogic output, acting on "plus" and "minus" push-buttons with 1,25V incremental intervals, selecting one of the previous possible values. Increments and decrements got by push-buttons are circular, this means that the output will shift from 10V to 0V for an increment and from 0V to 10V for a decrement.
The change is forbidden if the analogic outputs are simulated by "Cockpit".

Nr 8) Analogic input 0 diagnostic: Visualizes the analogic input 0 voltage level.

In selection phase is represented this way:

In run phase the leds visualize the analogic input 0 voltage level (-10÷10V), according to the following correlation:

Led0	on if 0analogic input voltage < -7,5V
Led1	on if 0analogic input voltage >= -7,5V
Led2	on if 0analogic input voltage >= -5,0V
Led3	on if 0analogic input voltage >= -2,5V
Led4	on if 0analogic input voltage >= 0V
Led5	on if 0analogic input voltage >= 2,5V
Led6	on if 0analogic input voltage >= 5,0V
Led7	on if 0analogic input voltage >= 7,5V

E.g. For an output voltage of 1,00V, the visualization will be as follows:

Nr 9) Analogic input 1 diagnostic: Visualizes the analogic input 1 voltage level.

In selection phase is represented this way:

In run phase the leds visualize the analogic input 1 voltage level (-10÷10V), according to the following correlation:

Led0 on if 0analogic input voltage < -7,5V
Led1 on if 0analogic input voltage >= -7,5V
Led2 on if 0analogic input voltage >= -5,0V
Led3 on if 0analogic input voltage >= -2,5V
Led4 on if 0analogic input voltage >= 0V
Led5 on if 0analogic input voltage >= 2,5V
Led6 on if 0analogic input voltage >= 5,0V
Led7 on if 0analogic input voltage >= 7,5V

Nr 10) DC bus voltage diagnostic: Visualizes the drive Dcbus voltage level.

In selection phase is represented this way:

In run phase the leds visualize the drive Dcbus voltage level (-10÷10V), according to the following correlation. The voltage range visualized is limited between 0V and 900V (OVER_VOLTAGE_LIMIT).

Led0 on if Dcbus voltage > 91.8V
Led1 on if Dcbus voltage > 183.6V
Led2 on if Dcbus voltage > 275.4V
Led3 on if Dcbus voltage > 367.2V
Led4 on if Dcbus voltage > 459.0V
Led5 on if Dcbus voltage > 550.8V
Led6 on if Dcbus voltage > 642.6V
Led7 on if Dcbus voltage > 734.4V

E.g. For a DCbus voltage of 300V, the visualization will be as follows:

Nr 11) Module temperature diagnostic: Visualizes the power module temperature.

In selection phase is represented this way:
.

In run phase the leds visualize the power module temperature, according to the following correlation.
The visualized range is between 0 and 90 C°. (OVER TEMPERATURE alarm).

Led0	on if temperature >	10,5 C°
Led1	on if temperature >	21,0 C°
Led2	on if temperature >	32,0 C°
Led3	on if temperature >	42,5 C°
Led4	on if temperature >	53,0 C°
Led5	on if temperature >	64,0 C°
Led6	on if temperature >	74,5 C°
Led7	on if temperature >	85,0 C°

E.g. For a temperature of 45 C°, the visualization will be as follows

10 OSCILLOSCOPE

10.1 General description

The regulation and control firmware on board of the AXM drive, includes an integrated module devoted to data acquisition, that simulates the features of a real oscilloscope.
The properties of such module are the following:

- 4 selectable acquisition channels.
- Programmable sampling frequency.
- Configurable sample number/acquisition.
- Trigger on a separate channel fully configurable (level, edge, pre-trigger).
- Acquisition manual or by event trigger.

The total time for an acquisition is owing to the sampling frequency, configurable from the related parameter and from the number of samples/channel. The max number of samples/channel depends from the selected number of channels, from a max of 8192 samples each active channel, to 2048 for the 4 selected channel.

The "Cockpit" configutator includes a graphic interface for the visualization of the acquisitions and the settings of the oscilloscope parameters.
This interface can be activated pressing the key in the instrument bar.

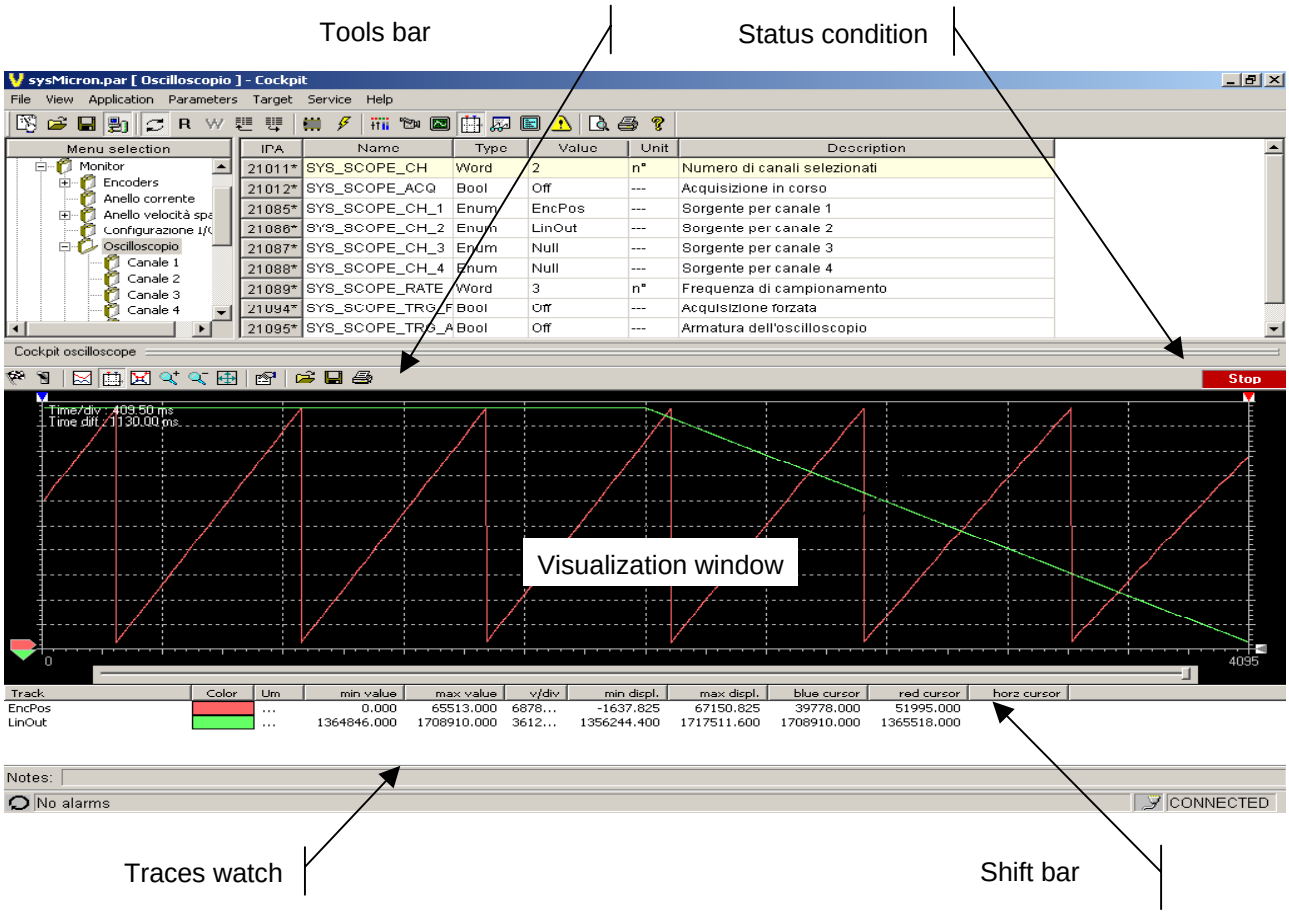

Tools bar
Status condition
sysMicron.par [Oscilloscopio] - Cockpit
File View Application Parameters Target Service Help
Menu selection
Monitor
Encoders
Anello corrente
Oscilloscopio
Canale 1
Canale 2
Canale 3
Canale 4
IPA Name Type Value Unit Description
21011* SYS_SCOPE_CH Word 2 n° Numero di canali selezionati
21012* SYS_SCOPE_ACQ Bool Off --- Acquisizione in corso
21085* SYS_SCOPE_CH_1 Enum EncPos --- Sorgente per canale 1
21086* SYS_SCOPE_CH_2 Enum LinOut --- Sorgente per canale 2
21087* SYS_SCOPE_CH_3 Enum Null --- Sorgente per canale 3
21088* SYS_SCOPE_CH_4 Enum Null --- Sorgente per canale 4
21089* SYS_SCOPE_RATE Word 3 n° Frequenza di campionamento
21095* SYS_SCOPE_TRG_A Bool Off --- Armatura dell'oscilloscopio
Cockpit oscilloscope
Stop
Time/div : 409.50 ms
Time diff : 1130.00 ms
Visualization window
0
4095
Track Color Um min value max value y/div min displ. max displ. blue cursor red cursor horz cursor
EncPos 0.000 65513.000 6878... -1637.825 67150.825 39778.000 51995.000
LinOut 1364846.000 1708910.000 3612... 1356244.400 1717511.600 1708910.000 1365518.000
Notes:
No alarms
CONNECTED
Traces watch
Shift bar

Figure 10.1: Oscilloscope graphic interface

10.2 Acquisition setting

Before beginning an acquisition you must set the active channels and the related variables to be sampled. Pressing the key on the oscilloscope instrument bar, a dialog box will be open: this will allow you to set the acquisition channels and the properties of the trigger event.

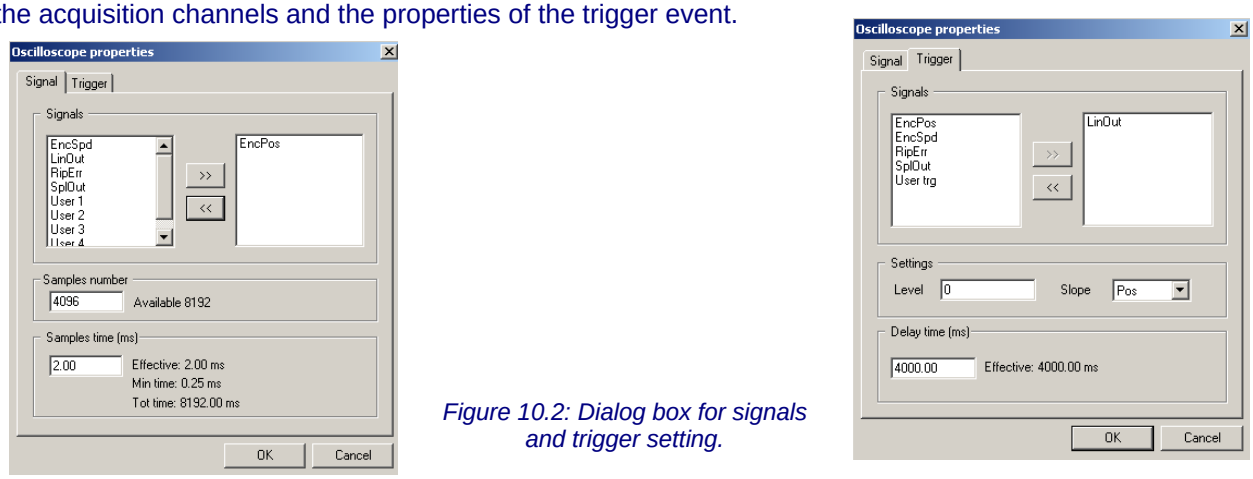


Figure 10.2: Dialog box for signals and trigger setting.

Signals: some predefined signals are allowable (vedi appendice 6), in addition to 4 “User” signals to whom the user can associate system variables in the dedicated applications: this increases considerably the range of variables allowable for sampling.
To set out a channel, select the desired signal and press the overhanging push-button to transfer it on the right of the frame. To exclude a signal follow the same procedure from right to left with the lower push-button.. 4 selections are possible.
In the central frame is set out the number of samples to be acquired each trace. On side is reported the max number of samples related to the number of selected channels.
In the lower control the sampling time (expressed in milliseconds) can be set out. On side is reported the effective sampling time, the minimal resolution allowed and the total acquisition time each selected channel.

Trigger: the trigger selection occurs in the same way as the signal have been set out.
Set out also the level, the trigger event activation edge and the position, expressed in milliseconds, inside the acquisition window. This value is automatically limited to the acquisition time/channel (in case a higher value should be set out). On side is shown the effective value related to the minimum resolution allowed.

10.3 Data acquisition

The oscilloscope is prearrenged to carry out a data acquisition manual or when a trigger event occurs.

The manual acquisition is activated by the key of the oscilloscope instrument bar: the key is disabled if no acquisition channel is set out.

The acquisition by trigger is activated pressing the key that “set” the oscilloscope, or rather prearranges it to test the trigger event to start the acquisition. The key is disabled if no acquisition channel or trigger is set out.
The oscilloscope condition is visualized on the instrument bar.
After the acquisition, follows a phase of transfer of the acquired data from the drive to the configurator using Modbus protocol. As the transfer is ended, the data are visualized in the oscilloscope window, while in the watch window the data related to the individual channels are visualized.

Using the keys it’s possible to perform a data zoom while, using the shift bar, to move inside the window. With the key you come back to the acquisition window.

Using the keys it’s possible to perform the vertical split of several traces, activate the vertical and horizontal cursors and visualize the acquisition points.
As last, the user can start the print of the visualization window and print the acquired data in a text file using the command keys or reload a file previously saved.

11 APPENDIXES

11.1 **Appendix 1 -** AxM drive alarm list

As much the alarm code increases, as its importance decreases. If more alarms are together active, the drive visualizes by leds only the more important (e.g. if the alarm Nr 9 **"Fan lock"** and Nr 22 **"Endat alarm"** are active, the Fan lock alarm only is visualized. To get a complete list of the active alarms, use the configurator "Cockpit" (see paragraph 3.5).
In the second column of the table is reported the error code mapped to the object 603Fh (Paragraph 6.2.1 Device Control objects) according to the DSP-402 specs.

Code	Emergency Code (DSP-402)	Alarm type	Description	Remedy
1	0x6188	**DSP communication error**	An error occurred, internal to the regulation and control firmware.	Contact the Phase Motion Control Service.
2	0x2110	**Short circuit**	A short occurred in the motor windings or inside the drive power module.	Verify the motor connections and possible shorts between motor phases and phase to ground.
3	0x2280	**Overcurrent**	The current has achieved an instant value higher than the max allowed by the drive.	Verify the loop gains setting, the possible mechanical obstacle and the correct motor size for the actuated use.
4	0x3200	**DC-BUS overvoltage**	A too high voltage level on D.C. Link has been detected.	Verify if the brake resistor is present and connected.
5	0x4200	**IGBT module overtemperature**	The power module has reached an excessive temperature.	Too heavy work cycle.
6	0x4300	**IGBT brake desaturation**	Brake circuit failure.	Braking resistor too low value or shorted or braking IGBT failure.
7	0x7113	**DSP synchronization error**	An error occurred inside the regulation and control firmware.	Contact the Phase Motion Control Service
8	0x6180	**Heatsink overtemperature**	The heatsink has reached an excessive temperature.	Too heavy work cycle.
9	0x4140	**Fan lock**	The drive reports a bad performance of the cooling system.	Verify possible obstructions of the cooling air flux or fan hindrance.
10	0x7110	**Brake always active**	The braking circuit is always active.	The supply voltage is too high or the clamp activation voltage is too low. Verify parameter *SYS_OV_CLM_LIM* (IPA 18108).

11	0x7112	**Brake Overpower**	The power lost in the braking resistor is higher than the maximum allowed.	Connect an external resistor of higher power rating.
12	0x7111	**Braking resistor error**	Temporary alarm coming before the "Brake overpower" message. Try anyhow to stop the motor before the drive disabling.	See "Brake Overpower".
13	0x6181	**Fast task overtime**	The run time of Fast task is longer than its activation period (250us).	If a user application is active, optimize the Fast run time. If "default" mode or a base application are active, then contact the Phase Motion Control Service.
14	0x6320	**Invalid system parameters**	The drive parameters have not been correctly saved during a user saving or during a drive turn off.	Try to repeat the saving and reset the drive. If the problem persists, contact the Phase Motion Control Service.
15	0x5520	**Flash device Error**	The flash sector where the parameters are saved, is damaged.	If the problem persists, contact the Phase Motion Control Service.
16	0x6128	**Fpga program error**	An error occurred during the fpga programming, on board of the drive.	If the problem persists, contact the Phase Motion Control Service.
17	0x6183	**Dsp program error**	An error occurred during the drive power module firmware code downloading.	If the problem persists, contact the Phase Motion Control Service
18	0x7600	**Lock Drive**	The drive is locked after a parameters saving.	Turn off and on again the drive or run a reset from the configurator.
19	0x8500	**Encoder counting error**	The drive has detected an incorrect index position.	Check the encoder cabling (E1) and the shield connection; verify also the parameter related to the index tolerance.
20	0x6200	**Application not loaded**	Error in application mode: the drive has been started in PLC mode without any executable application loaded.	Load an application to be executed or set SYS_SEL_MODE = default. SYS_SEL_MODE: IPA 18051
21	0x4310	**Motor overtemperature or PTC disconnected**	The PTC has detected a too high motor temperature.	Verify the connection of the motor PTC (E1) to the correct drive terminals and the real motor temperature.
22	0x6186	**Endat alarm**	Error in endat communication or device in alarm condition.	Check connections between endat and AxM drive.
23	0x6189	**Error on encoder analog levels**	The voltage ripple of the encoder analogic channels, was higher then the max limit set by the parameter SYS_AD_RIPPLE_LIM (IPA 18234).	Verify the connection of the encoder to the drive encoder port (E1).

24	0x8500	**Auxiliary encoder counting error**	The drive has detected an incorrect index position on the auxiliary encoder.	Check the encoder cabling (C1) and the shield connection; verify also the parameter related to the auxiliary encoder index tolerance.
25	0x1000	**Reserved**		
26	0x1000	**Reserved**		
27	0x6184	**Medium task overtime**	The task operation time is longer than its activation time (2ms).	If a user application is active, optimize the task performance time.
28	0x6185	**Slow task overtime**	The Slow task operation time is longer than its activation time (8ms).	If a user application is active, optimize the Slow task performance time. If "default" mode or a base application are active, then contact the Phase Motion Control Service.
29	0x8600	**Electric shaft position error**	The error between the position read by the drive and the position of the master shaft is larger than the allowed error limit.	Verify than the shaft controlled by the AxM drive is free to follow the master shaft. Check the speed loop gains and the parameter related to the limit error.
30	0x8100	**Alarm on fieldbus devices**	Incorrect configuration of the CANopen net or protocol error.	Refer to the specific code alarm (Chap 11.5 Appendix 5) for further information. Check the configuration parameters.
31	0x6187	**Endat inizialization Error**	Error during the initial phase of the endat configuration.	Check connections between the endat and the AxM drive.

11.2 **Appendix 2 -** System variables map

A table follows reporting the description of the system variables in the file **AxmVarsX.plc**.

Digital inputs:

Name	Type	Image	Description
sys250DI0 – sys250DI7	BOOL	No	Drive **digital inputs**. The regulation and control firmware cyclically reads the inputs with 250us period.
sysDI0 - sysDI7	BOOL	Yes	**Digital inputs**: these are the imaged variables related to *sys250DI0 – sys250DI7*. Use such variables if you want to read the inputs with period different from 250us.

Digital outputs:

Name	Type	Image	Description
sys250DO0 – sys250DO7	BOOL	No	**Digital outputs**: *sys250DO0 – sys250DO3* are drive physical outputs, the remaining digital outputs simulated by the Control Panel. The regulation and control firmware cyclically activates the outputs with 250us period.
sysDO0 - sysDO7	BOOL	Yes	**Digital outputs**: these are the imaged variables related to *sys250DO0 – sys250DO7*. Use such variables if you want to read the inputs with period different from 250us.

Analogic inputs:

Name	Type	Image	Description
sys250AI0 – sys250AI2	INT	No	**Analogic inputs:** *sys250AI0 and sys250AI1* are drive physical inputs, *sys250AI2* is an analogic input simulated by Control Panel. The input values are included between 0 (analogic input at –10V) and 1023 (analogic input at 10V). The regulation and control firmware cyclically activates the outputs with 250us period.
sysAI0 – sysAI2	INT	Yes	**Analogic inputs:**: these are the imaged variables related to *sys250AI0 – sys250AI2*. Use such variables if you want to read the inputs with period different from 250us.

Analogic outputs:

Name	Type	Image	Description
sys250AO0 – sys250AO3	INT	No	**Drive analogic outputs:** set values included between 0 (analogic output at 0V) and 1023 (analogic output at 10V). *sys250AO0 and sys250AO1* are drive physical inputs, the remaining ones are simulated by the Control Panels. The regulation and control firmware cyclically activates the outputs with 250us period.
sysAO0 – sysAO3	INT	Yes	**Analogic outputs**: are the imaged variables related to *sys250AO0 – sys250AO3*. Use such variables if you want to read the inputs with period different from 250us.

"Power module" block:

Name	Type	Image	Description
sysDsp_Iq	INT	No	**Quadrature current request**: Quadrature current request expressed as internal units (ui): 100ui = 1Arms. The quadrature current coincides with the speed/position loop output (*sysSpl250_Out*) in speed control and with the current reference (*sysSpl250_CicIsqRef*) in current control. The variable is updated by the regulation and control firmware with 250us period. ***Avoid to modify from an application the value computed by the firmware*** (see Appendix 4).
sysDsp_Id	INT	No	**Direct current request**: expressed as internal units (ui): 100ui = 1Arms. Normally zero. The variable is updated by the regulation and control firmware with 250us period. ***Avoid to modify from an application the value computed by the firmware***.
sysDsp_Rho	UINT	No	**Field angle** : expressed as virtual counts (1 mechanical turn = 65535 virtual counts). Represents the position over the electrical turn, or: $P_{el} = P_{mecc} * N°_{cp}$ where: P_{el} = electric position P_{mecc} =mechanical turn position (*sysSpl250_ViPo*) $N°_{cp}$ = number of motor polar pairs. The variable is updated by the regulation and control firmware with 250us period. ***Avoid to modify from an application the value computed by the firmware***.

sysDsp_Iu	INT	No	**Phase U motor current**: expressed as internal units (ui): 100ui = 1Arms. This variable is read by drive power module regulation and control firmware with 250us period. When the drive is disabled, the variable does'nt represent the current but firmware internal use values (see Appendix 4). ***Avoid to modify from an application the value read by firmware***.
sysDsp_Iv	INT	No	**Phase V motor current** : expressed as internal units (ui): 100ui = 1Arms. This variable is read by drive power module regulation and control firmware with 250us period. When the drive is disabled, the variable does'nt represent the current but firmware internal use values (see Appendix 4). ***Avoid to modify from an application the value read by firmware***.
sysDsp_Iw	INT	No	**Phase W motor current** : expressed as internal units (ui): 100ui = 1Arms. This variable is read by drive power module regulation and control firmware with 250us period. When the drive is disabled, the variable does'nt represent the current but firmware internal use values (see Appendix 4). ***Avoid to modify from an application the value read by firmware***.
sysDsp_Ic_P_Fak	UINT	No	**Current loop proportional gain**: expressed as internal units (ui). The variable changes are put into effect with disabled drive only.
sysDsp_Ic_I_Fak	UINT	No	**Current loop integral gain**: expressed as internal units (ui). The variable changes are put into effect with disabled drive only.
sysDsp_Ic_D_Fak	UINT	No	**Current loop differential gain**: expressed as internal units (ui). The variable changes are put into effect with disabled drive only.

Main encoder:

Name	Type	Image	Description
sysEnc1_Type	UINT	No	**Main encoder type**: this is the copy of the system parameter *SYS_ENC1_TYPE* (paragraph 4.2). The *sysEnc1_type* changes are activated after the drive reset only.

sysEnc1_Pulse	UINT	No	**Main encoder pulses per turn**: expressed as encoder pulses. It is the copy of the system parameter *SYS_ENC1_CY_REV* (par. 4.2). Accepted values between 1 and 8192: values not included in this range cause the setting of the default value 1024. Changes to *sysEnc1_Pulse* are activated after the drive reset only.
sysEnc1_I_ViPo	UINT	No	**Main encoder index on turn position**: expressed as virtual counts. The firmware updates the variable at the first index passage. ***Avoid to modify from an application the value read by firmware.***
sysEnc1_I_ViTu	UINT	No	**Main encoder index position expressed as turns** : the firmware updates the variable at the first index passage. ***Avoid to modify from an application the value read by firmware.***

Auxiliary encoder:

Name	Type	Image	Description
sysEnc2_Type	UINT	No	**Auxiliary encoder type**: this is the copy of the system parameter *SYS_ENC2_TYPE* (paragraph 4.2). The *sysEnc1_type* changes are activated after the drive reset only.
sysEnc2_Pulse	UINT	No	**Auxiliary encoder pulses/turn**: expressed as encoder pulses. It is the copy of the system parameter *SYS_ENC2_CY_REV* (paragraph 4.2). Accepted values between 1 and 8192: values not included in this range cause the setting of the default value 1024. Changes to *sysEnc2_Pulse* are activated after the drive reset only.
sysEnc2_ViSpd	DINT	Yes	**Auxiliary encoder speed**: expressed as normalized virtual counts at 32 bit (CntVi*2exp16)/250us. The firmware updates the variable with 2ms period. ***Avoid to modify from an application the value read by firmware.***

Motor:

Name	Type	Image	Description
sysMot_N_Poles	UINT	No	**Motor pole number**: expressed as internal units (ui): 100ui = 1Arms. It's a copy of the system parameter *SYS_MOT_N_POLES*. Refer to the paragraph 4.1 for further details. Changes to *sysMot_N_Poles* are activated after the drive reset only.
sysMot_Io	UINT	No	**Motor nominal current**: expressed as internal units (ui): 100ui = 1Arms. It's a copy of the system parameter *SYS_MOT_IN*. Refer to the paragraph 4.1 for further details. Changes to *sysMot_Io* are activated after the drive reset only.
sysMot_Idm	DINT	Yes	**Motor limit current**: expressed as internal units (ui): 100ui = 1Arms. It's a copy of the system parameter *SYS_MOT_IDM*. Refer to the paragraph 4.1 for further details. Changes to *sysMot_Io* are activated after the drive reset only.

Encoder simulation and electric shaft:

Name	Type	Image	Description
sysRip_Pulse	UINT	No	**Repeated pulses/turn** expressed as encoder pulses. Accepted values between 2 and 8192: only per values power of 2 (2, 4..512, 1024.. 8192); values not included in this range cause the setting of the default value 1024. Changes to *sysRip_Pulse* are activated only when the encoder simulation is not activated.
sysRip_Enable	BOOL	No	**Encoder simulation enabling** : enable the simulation after setting *sysRip_Pulse*.
sysRip_AsseElSpdAbs	UINT	No	**Electric shaft speed**: expressed as (CntVi)/2ms. Represents the absolute value of the auxiliary encoder that must be followed by the master. The firmware computes the speed with 2ms period. ***Avoid to modify from an application the value computed by firmware.***
sysRip_AsseElDir	INT	No	**Electric shaft motion direction**: represents the direction of the auxiliary encoder i.e. the sign of the variable *sysRip_AsseElSpdAbs*. ***Avoid to modify from an application the value read by firmware.***

sysRip_AsseElAlr	BOOL	No	**Electric shaft alarm activation**: if set to TRUE enables the alarm Nr 32 "Electric shaft position error ". The firmware controls the flag every 2ms to generate the related alarm.

"Ramp generator" block:

Name	Type	Image	Description
sysRg250_LinOut	DINT	No	**Ramp generator output**: expressed as normalized virtual counts at 32 bit (CntVi*2exp16)/250us. Represents the speed reference generated by the ramp generator. The firmware computes *sysRg_LinOut* every 2ms and copies it in the "Speed/position loop" input (see Appendix 4). ***Avoid to modify from an application the value computed by firmware.***
sysRg_LinOut	DINT	No	**Ramp generator output** : is the imaged variable related to *sysRg250_LinOut*. Use such variable if you want to work on the reference with update period different from 250us (see Appendix 4). ***Avoid to modify from an application the value computed by firmware.***
sysRg250_SpdRef	DINT	No	**Speed reference**: expressed as normalized virtual counts at 32 bit (CntVi*2exp16)/250us. It's the speed reference in input to the "Ramp generator" block. With disabled ramps, the firmware copies *sysRg250_SpdRef* directly in the "Speed/Position loop" block input with 250us period.
sysRg_SpdRef	DINT	Yes	**Speed reference**: expressed as normalized virtual counts at 32 bit (CntVi*2exp16)/250us. It's the speed reference in input to the "Ramp generator" block. With enabled ramps, the firmware updates the input with 2ms period.
sysRg250_PosspLim	UDINT	No	**Clockwise speed limit** : expressed as normalized virtual counts at 32 bit (CntVi*2exp16)/250us.
sysRg_PosspLim	UDINT	Yes	**Clockwise speed limit** : is the imaged variable related to *sysRg250_PosspLim*. Use such variable if you want to work on the reference with update period different from 250us.
sysRg250_NegspLim	UDINT	No	**Counterclockwise speed limit** . expressed as normalized virtual counts at 32 bit (CntVi*2exp16)/250us. The firmware updates the block every 8ms.

sysRg_NegspLim	UDINT	Si	**Counterclockwise speed limit** : is the imaged variable related to *sysRg250_NegspLim*. Use such variable if you want to work on the reference with update period different from 250us.
sysRg250_CwAcc	UDINT	No	**Clockwise acceleration** : expressed as normalized virtual counts at 32 bit (CntVi*2exp16)/(250us*250us).
sysRg_CwAcc	UDINT	Si	**Clockwise acceleration** : is the imaged variable related to *sysRg250_CwAcc*. Use such variable if you want to work on the reference with update period different from 250us.
sysRg250_CcwAcc	UDINT	No	**Counterclockwise acceleration** : expressed as normalized virtual counts at 32 bit (CntVi*2exp16)/(250us*250us).
sysRg_CcwAcc	UDINT	Yes	**Counterclockwise acceleration** : is the imaged variable related to *sysRg250_CcwAcc*. Use such variable if you want to work on the reference with update period different from 250us.
sysRg250_CwDec	UDINT	No	**Clockwise deceleration:** expressed as normalized virtual counts at 32 bit (CntVi*2exp16)/(250us*250us).
sysRg_CwDec	UDINT	Si	**Clockwise deceleration** : is the imaged variable related to *sysRg250_CwDec*. Use such variable if you want to work on the reference with update period different from 250us.
sysRg250_CcwDec	UDINT	No	**Counterclockwise deceleration**: expressed as normalized virtual counts at 32 bit (CntVi*2exp16)/(250us*250us).
sysRg_CcwDec	UDINT	Yes	**Counterclockwise deceleration:** is the imaged variable related to *sysRg250_CcwDec*. Use such variable if you want to work on the deceleration with update period different from 250us.
sysRg250_RampOff	BOOL	No	**Ramp generator disabling**: if set to FALSE enables the speed ramp, if to TRUE the speed step.
sysRg_RampOff	BOOL	Yes	**Ramp generator disabling** : is the imaged variable related to *sysRg250_RampOff*. Use such variable if you want to work on the flag with update period different from 250us.
sysRg_RampInCorso	BOOL	Si	**Ramp in progress**: is set to TRUE by the firmware when the ramp generator is enabled (*sysRg250_RampOff* = FALSE) and the output is different from the speed reference (*sysRg_LinOut* != *sysRg_SpdRef*). The flag is updated every 8ms (see Appendix 4). ***Avoid to modify from an application the value set by firmware.***

"Trajectory generator block":

Name	Type	Image	Description
sysPg_QTarget	DINT	Yes	**Position to be reached** : shows the position to be reached by positioning. The higher part of the variable expresses the turn number (from –32768 to 32767), the lower one the on turn position in virtual counts (from 0 to 65535). The firmware reads the dimension every 8 ms.
sysPg_PosOk	BOOL	Yes	**Position reached**: shows that the actual position (turns+position) coincides with the position set by means of *sysPg_QTGiri*. The firmware reads the dimension every 8 ms (see Appendix 4). ***Avoid to modify from an application the value set by firmware.***
sysPg_PosizEn	BOOL	Yes	**Profiles generator enabling**: setting the flag to TRUE, the "Profiles generator" block is enabled. The firmware reads the dimension every 8 ms.

"Speed/Position feed-back loop" Block:

Name	Type	Image	Description
sysSpl250_PosRef	UDINT	No	**Position reference**: . expressed as normalized virtual counts at 32 bit (CntVi*2exp16). Represents the position reference in input to the "Speed/Position loop" block. The firmware computes *sysSpl250_PosRef* every 250us. ***Avoid to modify from an application the value computed by firmware.***
sysSpl_PosRef	UDINT	Yes	**Position reference** : is the imaged variable related to *sysSpl250_PosRef*. Use such variable if you want to work on the reference with update period different from 250us ***Avoid to modify from an application the value computed by firmware.***
sysSpl250_TurRef	DINT	No	**Reference as turns**: expressed as encoder turns number. Represents the position reference in turns as input to the "Speed/Position loop" block. The firmware computes *SysSpl250_TurRef* every 250us. ***Avoid to modify from an application the value computed by firmware.***

sysSpl_TurRef	DINT	Yes	**Reference as turns** : is the imaged variable related to SysSpl250_TurRef. Use such variable if you want to work on the reference as turns with period different from 250us. ***Avoid to modify from an application the value computed by firmware.***
sysSpl250_PosGiriRef	DINT	No	**Position reference**: expresses the reference position as turn number and position on the turn. The higher part of the variable shows the turns number (from –32768 to 32767), the lower one the position on the turn as virtual counts (from 0 to 65535). ***Use this variable if you want to set reference inputs in the "Speed/Position loop" block when the references computed by the firmware are disabled by the related system parameter*** *SYS_SPL_REF_EN* (see par. 4.4.2).
sysSpl_PosGiriRef	DINT	Yes	**Position reference**: is the imaged variable related to *sysSpl250_PosGiriRef*. ***Use this variable if you want to set reference inputs in the "Speed/Position loop" block when the references computed by the firmware are disabled by the related system parameter*** *SYS_SPL_REF_EN* (see par. 4.4.2).
sysSpl250_SpdRef	INT	No	**Speed reference**: expressed as virtual counts every 250us (CntVi)/(250us)*2exp16. It represents the speed reference as input to the "Speed/Position" block. If the system parameter *SYS_SPL_REF_EN* is TRUE the value coincides with *sysRg_LinOut* (Appendix 4). ***Avoid to modify from an application the value computed by firmware*** when the references are enabled by the related system parameter *SYS_SPL_REF_EN* (see par. 4.4.2).
sysSpl_SpdRef	INT	Yes	**Speed reference**: is the imaged variable related to *sysSpl250_SpdRef*. Use this variable if you want to read the reference with update period different from 250 us. ***Avoid to modify from an application the value computed by firmware when*** the references are enabled by the related system parameter *SYS_SPL_REF_EN* (see par. 4.4.2).
sysSpl250_ViPo	UINT	No	**Actual position**: expressed as virtual counts. It's the main encoder position on the turn. The firmware updates sysSpl250_ViPo every 250us. ***Avoid to modify from an application the value computed by firmware.*** (see Appendix 4).
sysSpl_ViPo	UINT	Yes	**Actual position** : is the imaged variable related to *sysSpl250_ViPo*. Use this variable if you want to work with the encoder position with updating period different from 250 us (see Appendix 4). ***Avoid to modify from an application the value computed by firmware.***

sysSpl250_ViTu	DINT	No	**Actual turns**: expressed as encoder turns number. It represents the actual position as turns. The firmware computes *SysSpl250_ViTu* every 250us (see Appendix 4). ***Avoid to modify from an application the value computed by firmware.***
sysSpl_ViTu	DINT	Yes	**Actual turns** : is the imaged variable related to *sysSpl250_ViTu*. Use this variable if you want to work with the present position in turns with period different from 250 us (see Appendix 4). ***Avoid to modify from an application the value computed by firmware.***
sysSpl250_PosGiri	DINT	No	**Actual position**: expresses the encoder position as n° of turns and position on turn. The higher part of the variable shows the number of turns (from –32768 to 32767), the lower one the position on the turn as virtual counts (da 0 to 65535) (see Appendix 4). ***Avoid to modify from an application the value computed by firmware.***
sysSpl_PosGiri	DINT	Yes	**Actual position**: is the imaged variable related to *sysSpl250_PosGiri* (see Appendix 4). ***Avoid to modify from an application the value computed by firmware.***
sysSpl250_Spd	INT	No	**Actual speed** : expressed as virtual counts every 250us (CntVi)/(250us). The firmware computes the encoder present speed as position difference every 250 us. ***Avoid to modify from an application the value computed by firmware.*** (see Appendix 4).
sysSpl_Spd	INT	Yes	**Actual speed**: is the imaged variable related to *sysSpl250_Spd*. Use this variable if you want to work on present speed with update period different from 250 us (see Appendix 4). ***Avoid to modify from an application the value computed by firmware.***
sysSpl250_ErrRef	DINT	No	**Position error**: expressed as virtual counts. It represents the position error (turns + position) between the references and the present position. The firmware computes the error every 250us. ***Avoid to modify from an application the value read by firmware.*** (see Appendix 4).
sysSpl_ErrRef	DINT	Yes	**Position error** : is the imaged variable related to *SysSpl250_ErrRef*. Use this variable if you want to work with the position error with period different from 250 us (see Appendix 4). ***Avoid to modify from an application the value computed by firmware.***
sysSpl250_PosErrMax	UINT	No	**Max position error**: expressed as virtual counts. It limits to one single turn the value expressed by *SysSpl250_ErrRef* if the related flag *sysSpl250_PosErrEn* is set to TRUE. The control is actuated every 250us.

sysSpl_PosErrMax	UINT	Yes	**Max position error** : is imaged variable related to *sysSpl250_PosErrMax*. Use this variable if you want to set the error limit with period different from 250us.
sysSpl250_Out	INT	No	**Speed/Position loop output** : expressed as internal units (ui): 100ui = 1Arms. The Speed/Position loop in speed control represents the quadrature current request (*sysDsp_Iq*). The variable is updated by the control and regulation with period of 250us (see Appendix 4). ***Avoid to modify from an application the value computed by firmware.***
sysSpl_Out	INT	Yes	**Speed/Position loop output** : is the imaged variable related to *sysSpl250_Out*. Use this variable if you want to read the loop output with period different from 250 us. ***Avoid to modify from an application the value computed by firmware.*** (see Appendix 4).
sysSpl250_CicIsqRef	INT	No	**Current reference**: expressed as internal units (ui): 100ui = 1Arms. Represents the quadrature current in current control (*sysDsp_Iq*). The variable is read by control and regulation firmware with period of 250us.
sysSpl_CicIsqRef	INT	Yes	**Current request**: is the imaged variable related to *sysSpl250_CicIsqRef*. Use this variable if you want to set a reference in current control with period different from 250us.
sysSpl250_SpI	BOOL	No	**Speed/Position loop enabling**: setting the flag to TRUE, the Speed/Position control is selected, setting it to FALSE, the current control is selected. The firmware selects the control type every 250us.
sysSpl_SpI	BOOL	Yes	**Speed/Position loop enabling** : is the imaged flag related to *sysSpl250_SpI*. Use this flag if you wan to to work on the control selection with period different from 250us.
sysSpl_PosFak	UINT	Yes	**Position gain** : is the copy of the system parameter *SYS_SPL_POS_FAK* (paragraph 4.4). Set values between 0 and 32767. In the Speed/Position loop, the firmware acts with the position gain every 250us while the reading of the variable occurs every 8 ms.
sysSpl_IFak	UINT	Yes	**Integral position gain**: is the copy of the system parameter *SYS_SPL_I_FAK* (paragraph 4.4). Set values between 0 and 32767. In the Speed/Position loop, the firmware acts with the integral gain every 250us while the reading of the variable occurs every 8 ms.

sysSpl_VelFak	UINT	Yes	**Speed gain**: is the copy of the system parameter *SYS_SPL_SPD_FAK* (paragraph 4.4). Set values between 0 and 32767. In the Speed/Position loop, the firmware acts with the speed gain every 250us while the reading of the variable occurs every 8 ms.
sysSpl_AccFak	UINT	Yes	**Acceleration gain**: is the copy of the system parameter *SYS_SPL_ACC_FAK* (paragraph 4.4). Set values between 0 and 32767. In the Speed/Position loop, the firmware acts with the acceleration gain every 250us while the reading of the variable occurs every 8 ms.
sysSpl250_PosErr	INT	No	**On turn position error**: expressed as virtual counts It represents the error between the position reference on the turn and the actual position on it (see Appendix 4). ***Avoid to modify from an application the value computed by firmware.***
sysSpl250_PosErrEn	BOOL	No	**Position error enabling**: flag to activate the position error limit.
sysSpl250_IMax	UINT	Yes	**Max current request**: expressed as internal units (ui): 100ui = 1Arms. Represents the maximum limit of the current request (*sysDsp_Iq*). The limit is checked by the firmware every 250us.
sysSpl250_RhoSim	UINT	No	**Simulated magnetic angle**: expressed as virtual counts (1 mechanical turn = 65535 virtual counts). Represents the simulated position on the electric turn, i.e.: $P_{el} = P_{mecc} * N°_{cp}$ where: P_{el} = simulated electrical position P_{mecc} = simulated pos mechanical turn $N°_{cp}$ = motor polar pairs number. The variable is updated by the control and regulation firmware with period of 250us.
sysSpl250_SimPLC	BOOL	No	**PLC test enabling**: flag to enable the PLC test.

Alarms:

Name	Type	Image	Description
sysData_Alr	UDINT	No	**Active alarms**: represents the binary map of the system enabled alarms: every bit of the 32 allowable, means an alarm (according to numbering in Appendix 1)
sysData_EmergencyCode	UINT	No	**Emergency code**: is the code of the drive alarm with highest priority currently activated, according to the specification DSP-402. ***Avoid to modify from an application the value set by firmware.***

Oscilloscope:

Name	Type	Image	Description
sysOsc_UserS1-S4	DINT	No	**Oscilloscope source**: using these variables it's possible to select a determinate source to be sampled with the oscilloscope integrated in the drive firmware.
sysOsc_UserTrg	DINT	No	**Oscilloscope trigger**: using these variables it's possible to select a determinate source for the trigger event.
sysOsc_TrgSlope	UINT	No	**Trigger edge**: set to 1 if you want the trigger event on the rising edge of *sysOsc_UserTrg*, to 0 on the falling one.
sysOsc_TrgLevel	DINT	No	**Trigger level**: set the *sysOsc_UserTrg* value at the level able to generate the trigger event.
sysOsc_TrgOffset	INT	No	**Trigger offset**: represents the trigger delay referred to the first acquisition sample. Is expressed as samples number.
sysOsc_ArmScope	BOOL	No	**Oscilloscope starting**: the flag starts the oscilloscope to begin an acquisition in relation to the set trigger event.
sysOsc_TrgFScope	BOOL	No	**Forced acquisition**: rise the flag to TRUE to start the "manual" acquisition, i.e. without any trigger event.

System flags:

Name	Type	Image	Description
sysDriveEnable	BOOL	No	**Drive enabling**: flag for drive enabling.
sysSlowTsk	BOOL	No	**Slow Task enabling**: rise the flag to TRUE in the Init task of the user application, to activate the related Slow task.
sysFastTsk	BOOL	No	**Fast Task enabling**: rise the flag to TRUE in the Init task of the user application, to activate the related Fast task.
sysIndexOk	BOOL	No	**Encoder index presence**: the flag is risen to TRUE by the firmware 8ms long every transit on the encoder index.
sysInpPanel	BOOL	No	**Simulated inputs enabling**: rising the flag to TRUE the Control panel inputs are enabled and the drive physical inputs are disabled.
sysOutPanel	BOOL	No	**Simulated outputs enabling**: rising the flag to TRUE the Control panel outputs are enabled and the drive physical outputs are disabled.

System status flags: (DS 402 specification)

Name	Type	Image	Description
sysStatRdyToSwitchOn	BOOL	No	**Ready to switch on**: flag indicating the allowance for drive switching on. ***Avoid to modify from an application the value set by firmware.***
sysStatSwitchedOn	BOOL	No	**Switched on**: the flag shows that the drive is in normal operative condition, i.e. it can be enabled. ***Avoid to modify from an application the value set by firmware.***
sysStatOpEnabled	BOOL	No	**Operation enabled** : shows that the drive is enabled, power is applied to the motor and no alarm is activated.
sysStatFault	BOOL	No	**Fault**: shows that the drive is disabled because of an activated alarm. ***Avoid to modify from an application the value set by firmware***
sysStatVoltDisabled	BOOL	No	Disabled voltage flag.
sysStatQuickStop	BOOL	No	**Quick stop**: when set to FALSE, shows that the drive has followed a Quick Stop command. ***Avoid to modify from an application the value set by firmware.***
sysStatSwitchOnDisabled	BOOL	No	Disabled switch flag
sysStatRemote	BOOL	No	**Remote**: shows that the drive is enabled to receive and perform remote commands (e.g. on the CAN line). If the flag is on FALSE the drive cannot perform any remote command, but it can however send messages (e.g.: position, actual speed). . ***Avoid to modify from an application the value set by firmware.***
sysStatTargetReached	BOOL	No	**Target reached**: shows that the drive has reached the planned setpoint (speed or position related to the operation mode). A change in values causes the flag status change. ***Avoid to modify from an application the value set by firmware.***
sysStatLimitActive	BOOL	No	**Internal limit** : shows that the drive reached the set internal limits (e.g. current). ***Avoid to modify from an application the value set by firmware.***

System control flags: (DS 402 specification)

Name	Type	Image	Description
sysCtrlSwitchOn	BOOL	No	Switch on flag.
sysCtrlVoltDiasble	BOOL	No	Voltage disable flag.
sysCtrlQuickStop	BOOL	No	**Quick stop**: performs a drive stop with the mode set in quick stop option. The stop is activated setting FALSE.

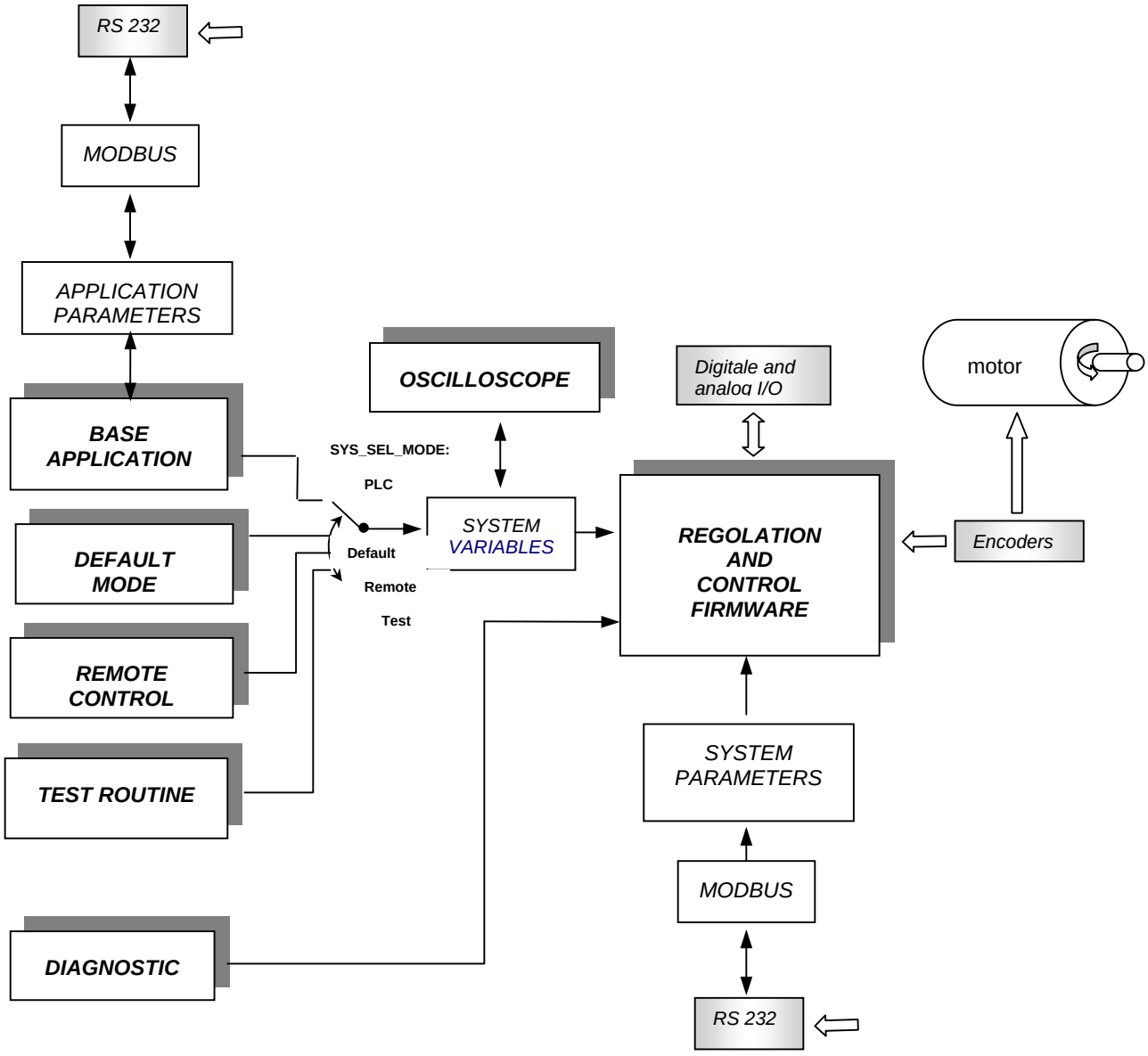
sysCtrlOpEnable	BOOL	No	**Operation enable**: flag for drive enabling only if no alarm is active. Setting the flag to FALSE, the drive is disabled.
sysCtrlResetFault	BOOL	No	**Reset fault**: performs a drive reset command in order to exit from the fault condition.

I/O configuration:

Name	Type	Image	Description
sysRef250_Sp_Offset	INT	No	**Speed reference input offset**: is the copy of the system parameter *SYS_SP_REF_OFFSET* (paragraph 4.5). Set as mV the offset related to the analogic input ANAIN0 used as speed reference. Expressed as internal units (ui) where: 1ui = 19,53 mV
sysRef_Sp_Offset	INT	Yes	**Speed reference input offset**: is the imaged variable related to *sysRef250_Sp_Offset*. Use this variable if you want to set the input offset with period different from 250us.
sysRef250_I_Offset	INT	No	**Current reference input offset** : is the copy of the system parameter *SYS_I_REF_OFFSET* (paragraph 4.5). Set as mV the offset related to the analogic input ANAIN1 used as current reference. Expressed as internal units (ui) where: 1ui = 19,53 mV
sysRef_I_Offset	INT	Yes	**Current reference input offset** : is the imaged variable related to *sysRef250_I_Offset*. Use this variable if you want to set the input offset with period different from 250us.
sysRef_Sp_Fak	UDINT	No	**Speed reference range**: is the copy of the system parameter *SYS_SP_REF_FAK* (paragraph 4.5.1). Expressed as: [(CntVi)/(250us)*2exp16]/cnt adc The firmware computes the range according to the speed limits and the analogic digital converter resolution: this reads the analogic input voltage following this equivalence: *SYS_SP_REF_FAK = MAX (SYS_RG_POS_SPLIM, SYS_RG_NEG_SPLIM) / 512* This computation is performed every 8ms. ***Avoid to modify from an application the value computed by firmware.***
sysRef_I_Fak	UDINT	No	**Current reference range**: is the copy of the system parameter *SYS_I_REF_FAK* (paragraph 4.5.1). Expressed as: ui/ cnt adc The firmware computes the range according to the current limits and the analogic digital converter resolution: this reads the analogic input voltage following this equivalence: *SYS_I_REF_FAK = (SYS_MOT_IDM) / 512* This computation is performed every 8ms. ***Avoid to modify from an application the value computed by firmware.***

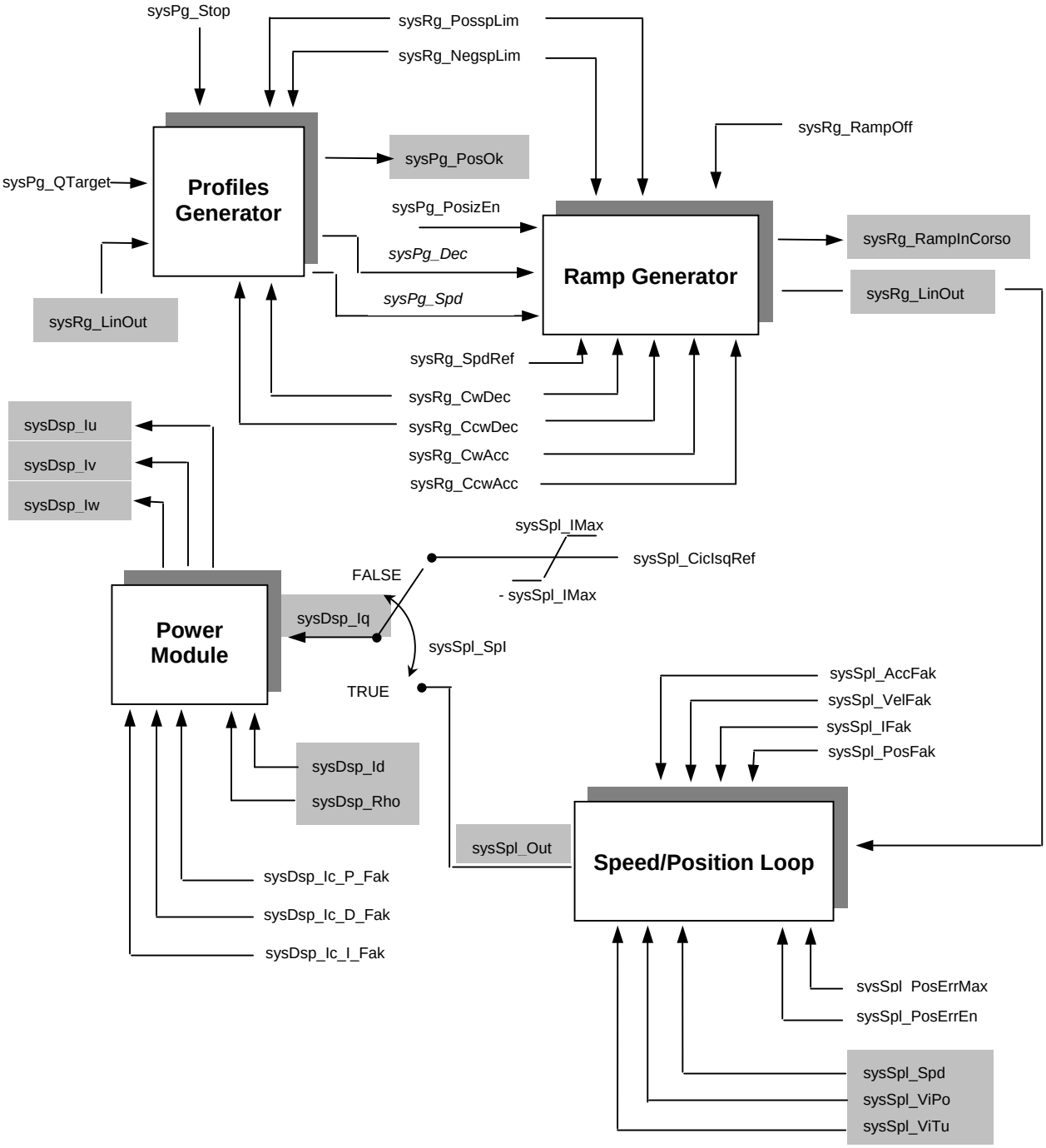
11.3 **Appendix 3 –** Iterazione firmware - applicazione

Firmware logic diagram and applicative interaction

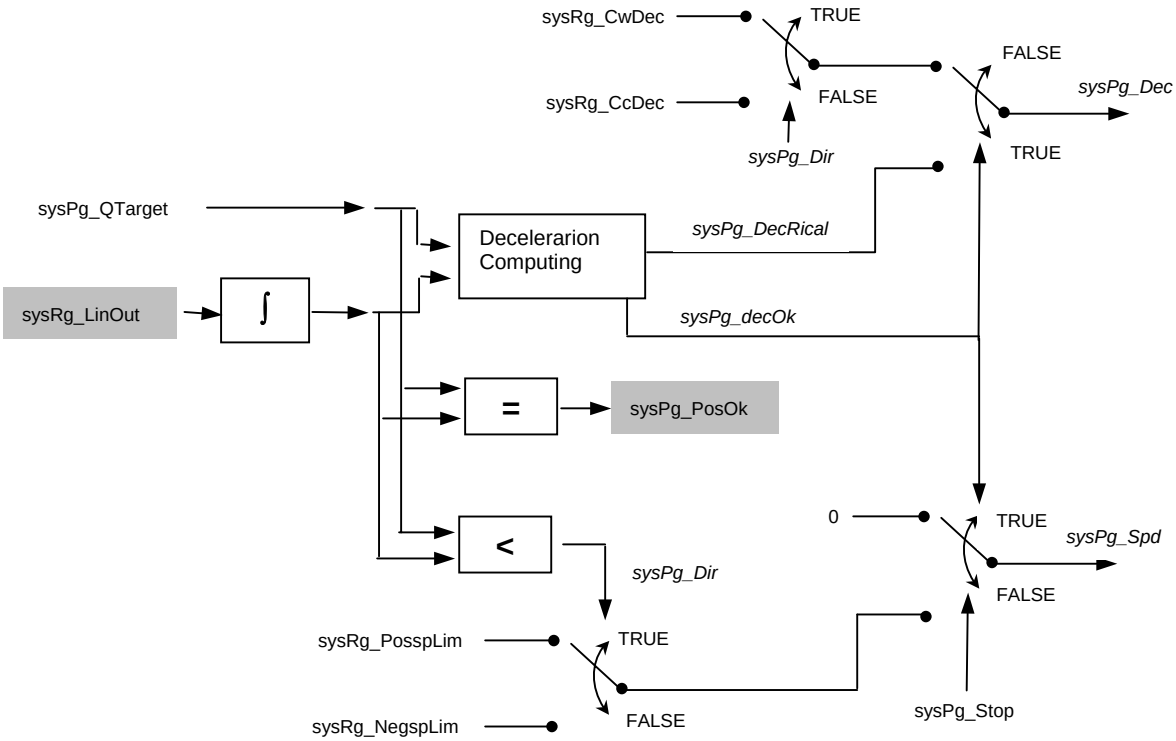


11.4 **Appendix 4 -** Regulation and control firmware general diagram.

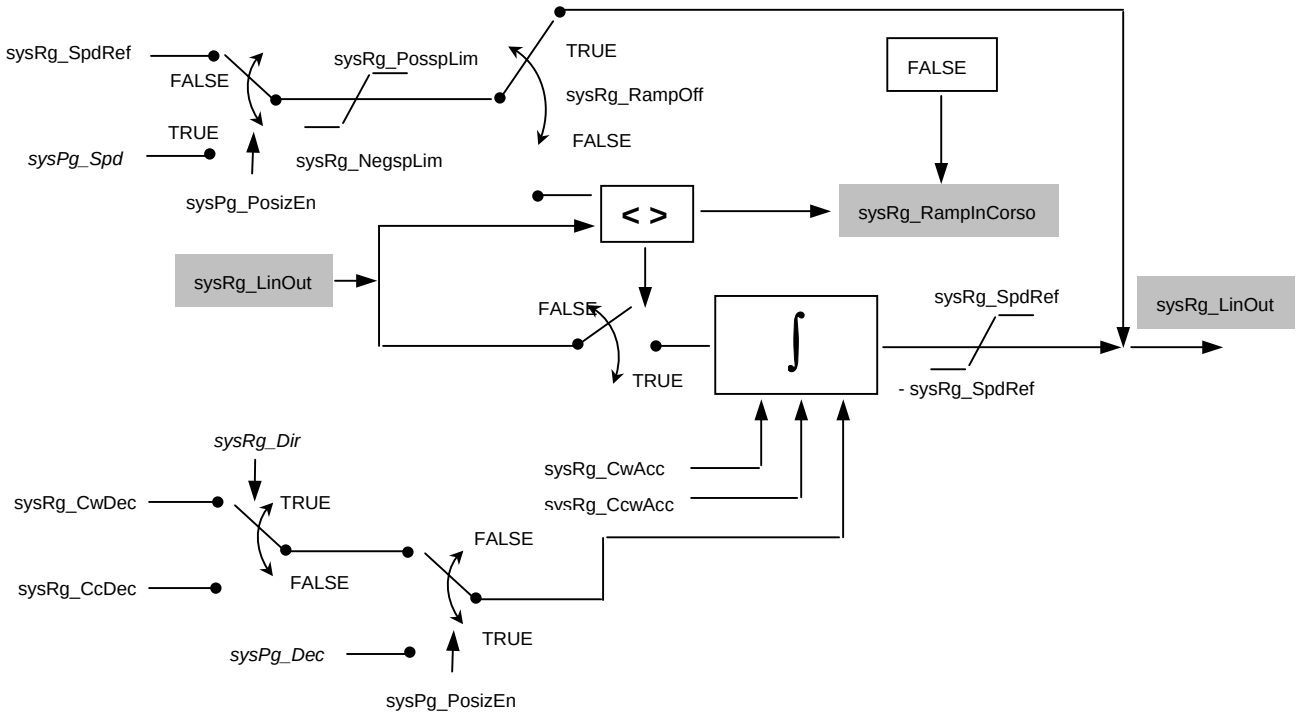
The variables shown on grey background indicate that their values are computed and updated by regulation and control firmware: then they absolutely must not be modified by the user application. The variables shown in italic are internal of the firmware, inaccessible to the user.



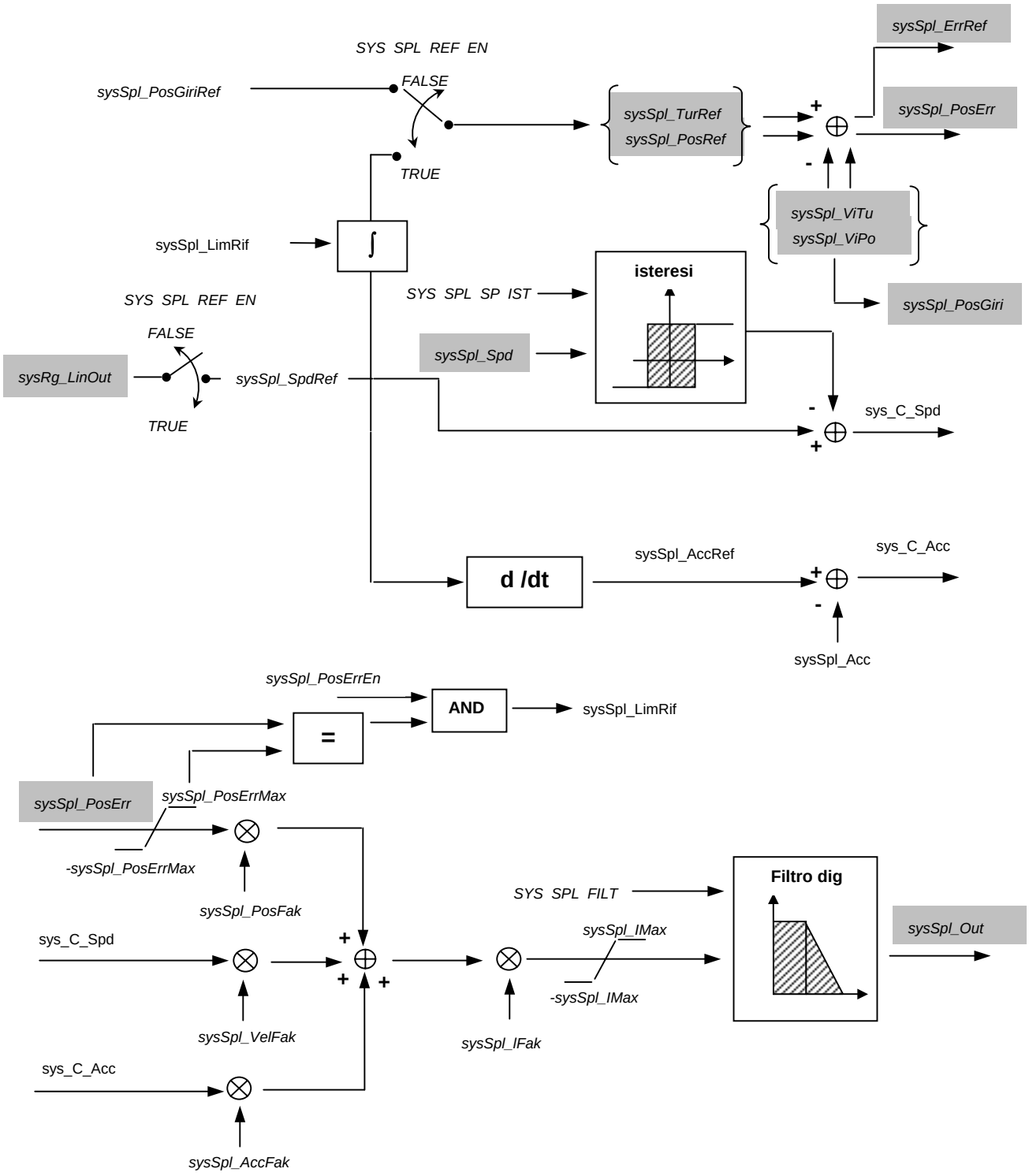
Profiles generator:



Ramp generator:



Speed/Position Block:



11.5 Appendix 5 - CanOpen alarms

Follows a descriptive table reporting the CanOpen alarm codes (system alarm nr 30 **Fieldbus devices alarm**). The codes are visualized in the system variable SYS_FAIL IPA 21201 (see par. 4.6.8).

Code	Alarm type	Description	Remedy
0x0000	**Drive OK**	No errors detected by drive on the CanOpen line.	
0x0001	**CanOpen Network Node Error**	A not allowed node number has been set.	Verify the system parameters settings (§4.6). Be sure that with enabled CanOpen line, the node number is set between 1 and 127.
0x0002	**SDO length error**	An SDO of not allowed length has been received.	Verify the length of the SDO messages sent by master: it must be 8 byte.
0x0004	**NMT length error**	An NMT of not allowed length has been received.	Verify the length of the NMT messages sent by master: it must be 2 byte.
0x0008	**Invalid NMT error**	An invalid NMT message has been received.	Verify the NMT messages NMT sent by master: they must carry one of the following codes: NMT_START (1) NMT_STOP (2) NMT_PRE (128) NMT_RESET (129) NMT_RES_COM (130)
0x0010	**Bus Loss Error**	A timeout error occurred in the Node Guarding control. No NG or SYNC message arrived inside the set period.	For Node Guarding on sync signal: check the syncPeriod (1006h) parameter setting. As default is set to 2ms. For NG message control: verify the GuardTime (100Ch) and LifeTimeFactor (100Dh) parameters. As default they are respectively set to 20 and 3ms.
0x0020	**Bus Off Error**	An hardware error occurred on the Can line.	Check the Can network connections integrity.
0x0040	**Operative condition error**	The drive has been enabled in preoperative condition.	Be sure that the drive turns in the operative condition before to be enabled.
0x0100	**Rx PDO1 length error**	The object mapped in Rx on the PDO1 exceed the 8 byte length.	Modify the PDO1 Rx map (§4.6.3).
0x0200	**Rx PDO2 length error**	The object mapped in Rx on the PDO2 exceed the 8 byte length.	Modify the PDO2 Rx map (§4.6.4).

0x0400	**Synchronization error**	A synchronization loss occurred with the sync message coming from master.	Verify that the master sync message has non variable frequency. In case act on the synchronization correction parameter. (§4.6.2) or disable the alarm with the system parameter 18301.
0x0800	**PDO mapping error**	The PDO have not been correctly configured.	Check that the mapped objects do exist and that they have been mapped consecutively inside one PDO. If the PDOs have been dinamically mapped, be sure that, as answer to their activation, the drive has not returned an abort code SDO.
0x1000	**Tx PDO1 length error**	The object mapped in tx on the PDO1 exceed the 8 byte length.	Modify the PDO1 tx map (§4.6.6).
0x2000	**Tx PDO2 length error**	The object mapped in tx on the PDO2 exceed the 8 byte length.	Modify the PDO2 tx map (§4.6.7).
0x4000	**Busy line error**	A timeout error occurred in SDO messages transmission.	Verify the Can line load. The timeout for transmission of SDO messages is set by default to 200 ms.